

Effectiveness of Computer Training  
on Attentional Skills

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## **Abstract**

This paper presents two studies, both examining the efficacy of a computer programme (Captain's Log) in training attentional skills. The population of interest is the traumatically brain injured. Study #1 is a single-case design that offers recommendations for the second, larger (N=5) inquiry. Study #2 is an eight-week hierarchical treatment programme with a multi-based testing component. Attention, memory, listening comprehension, locus-of-control, self-esteem, visuo-spatial, and general outcome measures are employed within the testing schedule. Results suggest that any improvement was a result of practice effects. With a few single-case exceptions, the participants showed little improvement in the dependent measures.

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## **CHAPTER ONE: BACKGROUND INFORMATION**

Two studies are presented within this paper. Both examine the efficacy of a computer system for remediation of attentional deficits subsequent to a traumatic head injury. To illustrate the present need for such efficacy studies, a brief account of the statistical information with regard to the incidence of head injury and the incidence of attentional disorders after a head injury are presented. Further, I also address microcomputers in the rehabilitation setting and an account of the controversy surrounding the value of attentional therapy with special consideration given to the Sohlberg and Mateer (1989) account. Finally, there is a section of this chapter devoted to the explanation of the terms used in text.

### **Incidence of Head Injury**

Statistics indicate that traumatic brain injury is the leading cause of death or disability under the age of 45. It is estimated that 16,000 Ontario residents annually have injuries severe enough to require hospitalization. Of this group 1,600 to 2,500 are left with physical, cognitive or behavioural consequences severe enough to prevent return to their pre-accident lifestyle. The number of head injuries, both fatal and non-fatal, have increased dramatically over the past decade (Ontario Head Injury Association Statistics, 1989).

With improved treatment and emergency intervention, survival following traumatic brain injury has increased. While the rate of survival has increased, rehabilitative strategies have remained in the embryonic stage. Much work has to be done to design and evaluate remediation programmes to ensure that these programmes will answer the needs of these individuals and improve their post-trauma lives. Rehabilitative efforts that would return the head-injured individual to an independent lifestyle would dramatically reduce the tremendous amount of money spent to

maintain inpatient care.

### **Attentional Deficits After A Head Injury**

Attention is considered the basis of most cognitive and neuropsychological functions (Bandura, 1969; Douglas, 1980; Kanfer and Phillips 1970; Newcombe, 1985). An attentional deficit can influence effective adaptive, academic and social functioning. The ability to concentrate or pay attention is a prerequisite for learning to occur. Douglas (1980) asserts that there is a definite relationship between attention and perception, memory and problem solving. Bandura (1969) and Kanfer and Phillips (1970) have emphasized that the ability to discriminate and to selectively attend to relevant cues is a major factor in social learning. With an attentional disorder, patients often display distractability, a failure to respond to cues from the environment and a variability in behaviour, such as apathy or agitation (Newcombe, 1985). Given the apparent importance and pervasiveness of an attentional deficit, it is not surprising that this sort of problem can influence everyday activities.

Consider the following statements: "When there are several steps to follow, I begin the second step and realize I have forgotten the first set of instructions." "I would like people to give me more time." "When I am playing cards, I can't concentrate on my hand and carry on a conversation at the same time." "When I am listening to the news I tend to drift off." These statements are common among patients who have suffered a head injury and reveal the complexity of an attentional disorder.

To behave effectively in any environment, one must be able to pick and choose from an enormous array of stimuli that is continually bombarding the senses. This requires a capacity to inhibit extraneous stimuli from both internal and external sources. This is an extremely complex process that is highly sensitive to brain insult

(Gentilini, Nichelli, & Schoenhuber, 1989; Stuss, 1991; Wood, 1990).

Among the most common symptoms following traumatic brain insult are concentration and memory problems (Binder, 1986). These results are consistent with findings of Mateer, Sohlberg and Crinean (1987). On the basis of a clinical survey they report that head injured individuals experience significantly more failures in the area of attentional demands when compared to normal controls.

With the introduction of sophisticated, noninvasive techniques (e.g., CT, PET, MRI) the necessity for using clinical neuropsychology as a means for neurological diagnosis is dwindling. To counter the diluted need for diagnostic measures, there has been an emergence of and a demand for effective management and treatment of cognitive deficits that follow brain insult. Accordingly, Benedict (1989) reports a shift in emphasis from diagnosis to treatment but, at the same time, cautions the rehabilitative strategist on the lack of empirical evidence. Sohlberg and Mateer (1989) simplify this issue further; they believe that the recent focus in cognitive rehabilitation is in the area of improving attention.

### **Microcomputers in Rehabilitation**

Considering the recent shift in focus to treatment concerns, and the frequency of attentional disorders and considering that attentional deficits are amenable to treatment (Gummow, Miller, & Dustman, 1983; Sohlberg and Mateer, 1989), a better understanding of rehabilitative strategies is critical. These strategies can vary from centre to centre but there seems to be one common denominator. Many cognitive rehabilitative programs make use of microcomputers. Bracey (1985) reported that 73% of the centres for cognitive rehabilitation use microcomputers in their clinical work with head-injured patients. Today, that number is probably a conservative estimate.

With the evolution of software for the microcomputer came the more sophisticated packages that are now available to facilitate concentration. This study will evaluate one representative system, the Captain's Log, a cognitive training system with an attention skills module.

The Captain's Log was the software of choice because it complies with the clinical criteria outlined by Sohlberg and Mateer (1989). This program is both interesting and easy to follow. The feedback is immediate and useful data are collected (e.g., incorrect choices, non-response errors -when no response is given, response errors, average reaction time). Supervision is minimal and the task becomes progressively more difficult as one advances to a higher level (e.g., beginner, intermediate, and advanced). In addition to the directives set out by Sohlberg and Mateer, the Captain's Log system has one unique feature: that is the use of alternative input devices which eliminates the need for the client to use the computer keyboard. Controlling input with a device (mouse) reduces the complexity and difficulty of client interaction with the computer. Finally, this version of Captain's Log was offered by an established company (MicroSoft) and is compatible with computers already in place in many rehabilitation settings.

The use of microcomputers has some distinct advantages for clinical cognitive rehabilitation. The presentation of stimuli is consistent, adjustable, and repetitive if necessary. As a result, the administration of these tasks is efficient. Immediate collection of performance data in conjunction with objective feedback are clear advantages when evaluating the client's progress. Moreover, the repetitive administration of a single task numerous times is labour intensive and can occupy a considerable amount of time. By making use of microcomputers, clinicians will have time to record qualitative data that might otherwise be lost. Thus, computerized cognitive rehabilitative systems are efficient and cost effective ways to provide



comprehensive training.

### **The Microcomputer Controversy**

Bracey (1983) argues that to maximize recovery of head injured clients it is important to place specific demands upon information processing. Reinforced practice, like that found with the computerized technique, would be a model of this remediation intervention. Although computer tasks are becoming more popular as a cognitive remediation tool, contradictory evidence with regard to their effectiveness is being reported. With a single case study, Bracey (1983) found an improvement in Wechsler Adult Intelligence Scale - Revised (WAIS-R) performance subsequent to practice with video-computerized attention tasks. Sivak, Hill and Olsen (1984), noted an improvement on computer tasks, but the effect failed to generalize to neuropsychological measures. Malec, Jones, Rao and Stubbs (1984) and Ponsford and Kinsella (1988) report similar results. Although there were significant practice effects, the computer protocol had no influence on outcome measures. These studies suggest that any observed treatment benefit was due to familiarity with computer tasks (practice effects) and/or the natural recovery of cognitive function (maturation effects) (Benedict, 1989).

### **Sohlberg/Mateer System**

Like Bracey (1983), Sohlberg and Mateer (1989) believe that treatment should target specific cognitive areas. Their Attention Process Training is a hierarchical, multilevel treatment programme. They administered the Paced Auditory Serial Addition Test (PASAT; Gronwall, 1977) twice during baseline and several times during the intervention. A hierarchy of organized computer tasks was based on a five-level model of attention (focused, sustained, selective, alternating and divided).

A progressively more demanding sequence of attentional exercises was administered to four brain-injured subjects, for a period of 5 to 10 weeks, according to this model. Gains in attention and on a visual task were seen during and following specific attention and visual process training. These results illustrate that attentional deficits in head-injured persons have the potential for remediation when therapeutic treatment has a specified directive.

Benedict (1989) reviewed most of the studies outlined above (under Sohlberg & Mateer, and Microcomputer Controversy) and believes that inadequate pretreatment baselines and inappropriate training tasks were responsible for negative outcome measures. These methodological problems could be addressed in a well-designed study. In consideration of the research to date, Benedict suggests that performance on selective attention and speed of processing tasks can improve in certain cases with repeated practice. Further, he commends the hierarchical approach used by Mateer, Sohlberg, and Crinean (1987) because they included a pre-treatment baseline and employed appropriate computer tasks.

### **Definition of Terms**

**Head Injury** or **Brain Injury** is a term that is often used interchangeably to describe an injury which results from a traumatic insult to the brain. Technically, it is unknown how many head injuries in fact do result in injury to the brain. Although most traumatic brain injuries are caused by motor vehicle accidents, some result from falls, sports injuries, and gunshot wounds.

**Traumatic Brain Injuries (TBI)** are classified "open" or "closed" brain injuries. The term **closed head injury** is used when the brain has been damaged without penetration of the skull. In contrast, the term **open head injury** is used when the

skull has been penetrated by an object. The damage resulting from open and closed head injuries differs.

**Closed Head Injuries** (or acceleration/deceleration injuries) are characterized by widespread damage to brain tissue. The resultant neurological disability reflects this widespread brain damage. This type of injury causes the brain, which is contained within a rigid skull, to move forcibly back and forth, hitting one side of the skull and rebounding with greater force to hit the opposite side of the skull. Shearing and tearing of many blood vessels and nerve fibres occur because of the forces involved.

The neurological deficits resulting from an **open head injury** depend on the area of brain specifically injured from the penetrating object.

**Plasticity** refers to the capacity of the brain to be shaped, moulded, or reorganized after an injury. Following an insult to the brain an individual can go through months or even years of rehabilitation often with remarkable results. There is a question whether their recovery is a result of reorganization (**plasticity**) or as a result of some behavioural change.

What will follow is a list of deficits that may manifest after an insult to the brain:

**Physical Impairments:** Paralysis or weakness, poor coordination, and balance difficulties.

**Sensory Impairments:** Diminished ability to appreciate and discriminate sensations of sight, smell, taste, touch, hearing.

**Perceptual Impairments:** Altered perception of self and the environment, including changes in the ability to perceive depth, distinguish objects from their surroundings, recognize spatial relationships, discriminate right and left, and visually track and scan.

**Communication Impairments:** Difficulties with understanding and expressing language in written, verbal, and non-verbal forms including talkativeness, unrelated verbalizations, peculiar use of phrasing, and disturbances in abilities to follow and participate in conversation.

**Behavioural Impairments:** There are personality and dispositional changes that may include mood swings, depression, loss of self-esteem, low tolerance, lack of emotional control, irritability, poor motivation, loss of initiative, lack of insight, restlessness, and changes in interpersonal and social skills.

**Other Impairments:** Seizures and chronic pain.

This list is not exhaustive because the brain can affect everything we are and everything we do. A person who has suffered a brain injury may experience any one or any combination of the deficits listed. Symptoms after brain injury vary greatly and are unique to each individual (Prigatano, 1990).

## **CHAPTER TWO: GENERAL REVIEW OF LITERATURE**

This study evaluates the efficacy of a computer system (The Captain's Log) in remediating an attentional deficit following a traumatic head-injury. Efficacy studies within the context of cognitive rehabilitation remain in the embryonic stage. A clear understanding of the nature of attention, attentional deficits, and effective rehabilitative techniques is critical for the rehabilitative specialist.

This portion of text begins with a brief examination of the theories regarding attention. Topics to be covered include information-processing speed, various aspects of attention and alternating versus divided processing. Derived from these experimental and clinical theories will be a model of attention that was used in this study.

### **Attentional Theories**

Attentional capacity is essential to cognitive functioning and everyday living, although there is no general agreement on the mechanisms of attention. Some experimental theorists interpret attention in terms of information-processing speed or capacity, that is, the amount of information that one can pay attention to and respond to in a given amount of time (e.g., Broadbent, 1982; Craik & Levy, 1976; Shiffrin, 1975). According to Ashcraft (1989), this view has been largely rejected and replaced with a more broadly conceived notion regarding attention, which describes attention as an active, multi-faceted component of cognition. Although this view may be slightly outdated, information-processing is one way of conceptualizing attention.

As previously mentioned, there is no universal agreement on the definition or mechanisms of attention; however, there are some aspects of attention that seem to predominate the literature. Attention is used in terms of general alertness or arousal, in other words the ability to focus on a particular stimulus. The ability to maintain

concentration or vigilance is another example. A third term consistently referred to in the literature with reference to attention is selectivity, that is, the ability to choose from competing internal and external stimuli.

Regarding selectivity, there seems to be some disagreement on the stage of information processing at which attention operates. Broadbent (1958) introduced a model of the brain as a limited capacity information-processing unit. The selectivity model holds that the discrimination of target and non-target information is processed at the perceptual level. In other words, there is a selective filter operating that chooses one channel at a time. Information that does not pass through this region is not processed any further.

Assuming that we can process information on one channel at a time, Treisman (1960, 1964) used a dichotic shadowing technique to investigate what information, if any, can be processed on an unattended channel. Messages are presented to both ears and the subject is asked to reiterate aloud (shadow) the message to one ear; the message to the other ear is unattended. In her attenuation model, the unattended message is not blocked out completely and the information is passed on in an attenuated or weakened form. Although one channel may be selected for further processing, the information coming in from other channels is not lost altogether. There is a possibility that subjects are alternating or shifting their attention to items of information in the unattended ear rather than processing the information simultaneously. Both Broadbent and Treisman agree that selection of a single channel occurs at the perceptual level before recognition processes are generated and thus their models are referred to as early selection models.

Deutsch and Deutsch (1963) and Norman (1968) present an alternate view called a late selection model. The general framework for the late selection model is that all information gains access to the recognition phase of analysis. This means that

information from all channels is recognized but only the most important, relevant items are processed at a higher conscious level.

Kahneman's (1973) capacity theory of attention differs from traditional models of attention in its consideration of active allocation of attentional resources. The theory postulates a central executive which allocates resources for incoming stimuli. One difficulty with Kahneman's model is the question of how much of the monitoring of stimuli and the allocation of attentional resources is unconscious. That is, can an individual consciously allocate attentional resources and perform two tasks simultaneously? Evidence from dual task experiments (e.g., Barber, 1989) demonstrate that people can perform several tasks simultaneously provided they are sufficiently rehearsed, so that the tasks are not too demanding. For example, we may listen to the radio while driving or carry on a conversation while walking. However, if we noticed a patrol car in the rear view mirror, we would stop speaking mid-sentence. Likewise, if the conversation suddenly included a breakthrough in a topic that we were very interested in, our footsteps might slow and stop. The ability to divide attentional capacity and to perform two tasks at one time is possible for over-learned tasks, but it is difficult to dismiss the possibility of rapid shifting from one task to another.

Sohlberg and Mateer's (1989) clinical model of attention spans five hierarchical stages: focused, sustained, selective, alternating and divided. Although, the five stages were included in their study, they still remain unable to identify the relative contribution of the components of the program or whether it is critical to work within each of the five levels. While there is agreement with the first four stages, the lack of experimental evidence with regard to serial versus parallel processing is discouraging. Serial processing demands that only one task is performed at a time, and the initiation of another task must be delayed until the completion of another with

higher priority. Parallel describes concurrent processing of two tasks. Consequently, the problem here applies to divided attention. One can never be sure if the subjects have actually rapidly switched their concentration from one task to another or have managed to maintain their attention on two tasks simultaneously. While this issue of alternating versus divided attention remains unresolved, this study will consider focused, sustained, selective and alternating attention within a hierarchical format of simple to complex. That is, subjects will be asked to perform all four of the attentional tasks at the beginner, intermediate, and advanced levels. This procedure will clearly define the subject's particular deficit and will allow the instructor to individualize and to concentrate treatment on the basis of performance. For example, the subject may be at the beginner level for alternating, but have reached advanced levels for focused and sustained attention. Beyond personalizing the treatment, this format could alleviate boredom and give the subject a sense of success within each session.

### **Changes Following Injury to the Brain**

Whether brain changes are a result of neuroplasticity or behavioural plasticity is the issue at hand. Does brain change somehow facilitate function, or does functional performance rely on the remaining healthy tissue or on compensatory strategies? In other words, if a client should experience a change in behaviour, is that change due to a neurological reorganization or is that behaviour change due to a performance adaptation (e.g., chunking, imagery)?

Brain cells do not regenerate when killed, and the physiological function performed by these cells is lost when neurons are destroyed. However, it is well known and well documented that partial or complete return of function may take place with the passage of time (e.g. Bigler, 1990; Finger, & Stein, 1982; Finger, LeVere,



Almli, & Stein, 1988). What we may be interpreting as a full or partial recovery may only be a superficial impression of improvement. The handicapped individual may be compensating by relying on alternative cues, different muscle groups or different cognitive strategies. Moreover, clinicians emphasize the use of compensatory strategies to circumvent functional disabilities (Prigatano, 1990). A person with a memory problem may carry a notebook and calendar so as not to forget therapy sessions or important meetings. Another individual with the same problem may actively avoid situations that would tax those skills (e.g., a party where he/she might be required to remember names and faces). Thus, it seems that restitution or the appearance of restitution can take several different directions.

There is considerable evidence that the brain will undergo changes in response to damage (for review see, Finger, & Stein, 1982; Finger, LeVere, Almli, & Stein, 1988). Steward, Cotman, and Lynch (1974) performed a sophisticated experiment that involved the creation of unilateral lesions in the entorhinal cortex of 11-day-old rats that were allowed to live to maturity. A recording electrode revealed that new potentials were generated from the fibres that originated in the intact cortex. This experiment provides physiological evidence that sprouting does occur and that the newly sprouted fibres are functional.

Stein (cited in Finger & Stein, 1982), revealed that certain compensatory physiological processes underlying recovery may vary from individual to individual. Following bilateral frontal lesioning, rats were trained on a delayed-spatial alteration task until the rats performed the task as well as healthy intact animals. A radioactive tracer was injected into both treatment and control animals. After decapitation, autoradiographs revealed that intact animals showed consistent patterns of uptake. However, the surgically-lesioned animals showed considerable variability in uptake - some in the geniculate and others in reticular regions. So, this analysis of recovery

suggests that physiological functional changes are susceptible to individual differences.

### **Recovery of Function**

Recovery of function (or a positive behavioural change) is dependent on several different variables, including age at the time of injury, locus of the injured tissue, the kind of damage inflicted, the time period that has elapsed since injury and personal history (Isaacson, 1975). These variables will be discussed in the context of the head injury.

#### **Age**

Regarding age, Lenneberg (1967) reports there is a good chance of complete recovery of certain functions, even after massive trauma, if the injury occurs early in life. This implies that the return of normal performance is as a result of radical reorganization of function in the developing brain, although the generality of this implication is in doubt (Finger & Almli, 1988). Unfortunately, the highest incidence of closed head injury occurs between the ages of 18 to 35 and even according to Lenneberg, recovery would usually be incomplete. However, contradictory evidence is presented by Finger and Stein (1982) in the form of several case studies. Although anecdotal evidence has to be considered with a great deal of caution, there is evidence that a mature brain can undergo serious injury with a remarkable degree of recovery.

Raisman (1969) provides documentation that physiological changes (collateral sprouting) are possible in the adult brain. In developmentally mature rats, both hypothalamic and fimbrial pathways sprouted new terminals in response to surgery. These are important observations because it allows optimism with regard to therapeutic interventions. This study suggests that with appropriate treatment,

recovery outcomes for mature clients can be maximized or enhanced. In other words, a behavioural change even in neurologically mature brains can be realized.

### **Locus of Injury**

As previously mentioned, recovery is dependent on locus of injury. Unlike the circumscribed lesion that surgical intervention will produce, lesioning following a closed head injury is diverse and variable dependent on the site of impact. The sequelae of brain trauma may be due to the primary lesion sites or to secondary affected areas or to an interaction of both (Isaacson, 1975). Despite the diversity of damage to the brain and the variability of symptoms, recovery can occur in head injured patients. Finger and Stein (1982) emphasize that it is important not to simply look at the anatomy of the lesion, but also the condition of the remaining tissue and the adaptive nature of behaviour following a head injury. They cite examples of clients with massive damage who exhibit remarkable resilience to the trauma and show impressive recovery. For example, they cite a report by Burklund and Smith (1977) that after an entire left hemisphere was removed, the client showed remarkable but slow recovery over a two-year period. Although verbal ability was compromised, the client could make appropriate, non-verbal gestures to simple commands. This might seem a conservative response in terms of restitution of function, but the surgical intervention was a three-stage process and following every stage the client overcame severe disabilities.

### **Period of Time Post-Trauma**

Period of time post-trauma is another issue that deserves reconsideration. A belief that recovery is confined to a few months post-trauma could undermine rehabilitative efforts and could reduce the client's expectations for any improvement

in function. Contrary to this belief, Finger and Stein (1982) review evidence that testifies to a "delayed" recovery from brain damage, but offers caution in that certain recovered functions seem to deteriorate at a later point in the client's life.

Blakemore and Falconer (1967) examined patients two and five years following left temporal lobectomies. At two years the clients showed little gains in paired association learning, but at five years managed to score at normal levels. It seems that even with a longer post-trauma period, appreciable recovery can be made in certain areas.

The present study will have as its experimental population a group of neurologically mature adults who have had severe brain damage and have had no cognitive treatment for 2 to 33 years post-trauma. If brain plasticity is a possibility after exposure to a complex stimuli, or if the area responsible for the function is partially intact, then it is possible that there will be a behavioural change.

### **Behavioural Adaptation**

Behavioural adaptation or compensation, as previously mentioned, is another vehicle for behaviour change. Behavioural compensation implies no radical reorganization or regrowth of the original damaged neural tissue. If positive change occurs, it is considered to be as a result of the functioning of undamaged brain areas, or as a result of the alternate behaviours that render the individual more (or even less) effective by changes in the remaining healthy neural tissue (Isaacson, 1975).

Restitution, or improvement of a major cognitive function (e.g., attention) following repeated exposure to a complex domain-specific cognitive task constitutes behavioural change. Clinical studies such as the current one can document and report factors that enhance behavioural plasticity. However, a longitudinal study with physiological correlates of brain function would be needed to address the issue of neuroplasticity.

## **CHAPTER THREE: STUDY #1**

Before launching a major study it was necessary to conduct a pilot investigation to minimize the possibility of problems. There were some concerns with regard to the simple nature of the computer system. Another possible obstacle related to the simple nature of the task was participant fatigue or boredom. The issue of moving the participants across attentional levels on a timed schedule was also a consideration. With all of these concerns in mind, and the problems encountered within the first study, what will follow is a presentation of the hypotheses generated by this inquiry, a brief description of the participant and a description of materials, tests, and design used in Study #1, the results of this study, and a discussion of the design improvements that were made as a consequence of the initial inquiry.

### **Hypotheses**

Specifically, the question that will be addressed is: Will the Captain's Log computer program effectively remediate the attentional skills of a head-injured person?

There are five hypotheses generated from the study:

1. The participant will demonstrate an increase in scores on attention measures compared to baseline levels. A positive change will be demonstrated as the participant proceeds through the treatment phase of the study. This improvement will occur as a result of exposure to complex, domain specific stimuli.
2. The participant will demonstrate little advancement in visuo-spatial scores compared to pre-treatment scores. There would be no expectation that acquired attentional skill would generalize to visuo-spatial scores because of the specific nature of the task.
3. The participant will demonstrate an improvement in areas of self-esteem and locus

of control compared to baseline. Test scores are anticipated to change because of a sense of accomplishment with an improvement in attentional skills.

4. There is an expectation that an improvement in attentional scores will reflect an upward score in the participant's scores on listening comprehension.

5. Reports of level of functioning will improve in the participant's living and learning environments compared to pre-treatment reports as measured by The General Functioning Questionnaire. The improved attentional skills will have a positive effect because distractability and confusion will be lessened and the head-injured individual will be better equipped to deal with every-day living.

## **Method**

### **Participant**

This participant was chosen by the therapeutic staff of a local Community Re-Entry Centre. The participant presented an attentional deficit specifically in the area of verbal and written instruction. This type of deficit can have a damaging effect when the person is placed in a working situation. This case presented a particular challenge because of the long portion of time post-injury. His parents have been the caregivers during the 20 years since his accident. Despite the length of time post-injury, he made consistent gains in many facets of the attentional program.

This was a voluntary assignment within the Re-Entry programme. A copy of the consent form is offered in Appendix A.

### **Materials-Testing Measures**

What will follow is a description of each of the tests used in Study #1. The first tests of this series will involve self-esteem and locus of control. These outcome measures were selected because there is an expectation that these exercises may have

an effect on psychosocial variables as well as cognitive variables.

1. The Index of Self-Esteem (ISE) (Hudson, 1982) is used to measure problems with self-esteem. The ISE has excellent internal consistency ( $\alpha = .93$ ) and stable test-retest reliability (.92). When considering a measure of self-esteem, it was important that the questions were appropriate for the population of interest. This questionnaire is the most appropriate for our needs. (See Appendix B).

The inclusion of the test was influenced by the two studies that report a significant change in self-esteem after exposure to a rehabilitation training programme. McGuire and Greenwood (1990) investigated the effects on a six week memory rehabilitation programme on the self-esteem of 18 clients with traumatic head injury. There was a significant improvement in self-esteem at the conclusion of the programme. Likewise, Kerner and Acker (1985) assessed the effectiveness of computer mediated memory retraining. The treatment group of head injured clients showed enhancement of memory skills and self-esteem. These improvements are noteworthy because Johnson and Newton (1987) noted after examining 11 severely brain injured individuals that low self-esteem is one of the factors contributing to poor social adjustment.

2. This Locus of Control Measure (LOC) (Reid, Ziegler, 1981) has two parts: Part 1 Desire of Outcomes, Part 2 Beliefs and Attitudes. The test-retest correlations at 6-, 12-, and 18-month intervals have been moderate, but respectable, because it is expected that scores will vary over time. The shortened version will be used because a respectable degree of internal consistency ( $\alpha = .70-.79$ ) remains when 35 items were reduced to 16 selective items. This was originally formulated for an elderly population but the questions were most relevant to this treatment group. (See Appendix C).

Unlike self-esteem, locus-of-control has received little attention within the brain-

injured population. There is some evidence (Boschen, 1990) that people disabled with spinal cord injury feel significantly more externally controlled than nondisabled clients. This test was included in order to better understand the effect of therapy on the social adjustment of the participant.

3. In order to establish if there were any particular gains extending to everyday living, the General Functioning Questionnaire was formulated. The General Functioning Questionnaire has two parts, a pre- and a post-training interview. This questionnaire will inquire about the subject's attentional skills, but these questions will be randomly dispersed among social, family and performance issues. There are no reliability values because the particular personal survey was designed for this study. (See Appendix D).

4. Kendrick's Object Learning Task (KOLT) (Kendrick, 1985) is a simple, time-efficient test of attention. The client is asked to remember several pictures on a card and then asked to recall and name the items, in any order. There is a series of four cards in both sessions, each card has progressively more items to be remembered with longer rehearsal times allowed for each card as the task becomes more difficult.

The reason for selecting the KOLT are twofold:

- 1) There are two sets of cards for pre- and post-testing, thus reducing the possibility of practice effects;
  - 2) Although in diagnosis only the total score is used, in research it may be valuable to consider the three component scores (repeated items, category items, and filler items).
- (See Appendix E).

5. The Attentional Capacity Test (ACT) (Weber & Segalowitz, 1990) was modified for use with children. This condensed version was chosen because with attentional problems of adults with head injuries there seems to be difficulties in the amount of information that could be attended to at one time (see Mack, 1986). In



addition, the shorter version allowed the maintenance of a time frame to avoid the problem of fatigue.

The amount of information a person can attend to or process at one time is often a key aspect in attentional problems experienced by brain injured adults. In this respect, the term attentional capacity is used synonymously with information processing capacity as it is understood that the amount of information that a person can attend to within a given time is limited by his/her ability and speed of processing.

The ACT can be used with people with motor and/or speech problems; it is not contaminated by other learned skill factors and can be used across a wide range of functional levels. Its construct validity has been established in normals, and its predictive validity has been established in clinical populations (Weber, 1988). (See Appendix F).

6. The Stroop Colour and Word Test (Stroop, 1935) that will be used is a modified version of the original. The premise of this test was that the naming of colour hues is always slower than the reading of colour names. It is a timed test. The participant will be asked to name the colour of a number of X's (XXXXXX) to ensure that colour perception is intact, then a second sheet will have differently coloured ink for the written word (the word BLUE will appear in orange ink). The last card is the most difficult; the words are written in different coloured ink, but then the following word is the name of the colour proceeding it. This last card requires the subject to inhibit his/her response. Test-retest reliability scores suggest that practice does have a small effect (5%) (Stroop 1935).

Also included in this test was a card featuring names of colours in black and white. This was introduced so the researcher was sure that the participant could read the names of the colours and that there was indeed a form of interference occurring between the names and the colours on subsequent tests.

This test was modified further for use within this population. The number of items was reduced to 39 compared to 112 items on the original version and then each item was enlarged to a height of 1 1/2 inches. This magnification alteration would ensure that each word is processed. By placing a word out of focus, one could name the colour of ink without attending or processing the word itself, thereby reducing the interference and inhibition effects (See Appendix G).

This measure of interference and inhibition is derived from the time it takes the participant to successfully complete 39 items.

7. Judgement of Line Orientation (JOLO; Benton, Hamsher, Varney, & Spreen, 1983) is a visuo-perceptual task that involves distinguishing the placement of a pair of lines when compared to 11 radiating lines that appear on the opposite page. There is strong evidence that there is a relationship between defective performance and right parietal dysfunction. The attentional measures will be sensitive to frontal lobe functioning and there is interest in the possibility of the task generalizing to other functional areas. Test-retest reliability is .90. (See Appendix H).

8. Right/Left Discrimination (Rt/Lt; Kolb, & Whishaw, 1985). There is a relationship between poor performance and left parietal disorder. Again, the rationale for choosing this test is the same as that for choosing JOLO, except this test is indicative of left parietal lobe involvement. It was important to have indices of cognitive function that were subserved by different neural systems in order to examine the possibility of the tasks generalizing across functional areas. (See Appendix I).

9. Durrell Analysis of Reading Difficulty (Durrell, 1955). The Analysis consists of a series of tests that will allow the examiner to observe various aspects of a person's reading ability. The portion of the analysis that was chosen for this study was Listening Comprehension Test because the participant had experienced problems with verbal instruction and sequencing.

This particular segment of the Analysis offers seven paragraphs, one for each grade level, with comprehension questions. The examiner reads a paragraph aloud in a normal voice, with normal speed and expression, then a series of comprehension questions follow. In this testing situation paragraphs from a Grade Two level and Grade Six level were chosen for comprehensive indices. To view a sample of the passages, refer to Appendix J.

Carroll (1986) considers the way we understand and recollect segments of language larger than a sentence. Remembering a paragraph or a segment of discourse requires a hierarchical arrangement of propositions, with higher-level propositions more available than lower-level propositions. Along with the propositions that are actually presented in text, we derive inferences in the process of understanding discourse. These inferred propositions are actually stored in memory with the propositions that were actually present in the discourse. Apparently, to be successful at the comprehension and the remembering of discourse, one must have the ability to organize material in a coherent fashion. The organization of a passage influences the comprehension and the later recall. The difficulty arises when one tends to pay greater attention to the parts of a paragraph rather than the general idea or schema. This would be represented in memory by separate chunks of information instead of a clear, coherent memory structure.

From this theoretical foundation, there are a few rehabilitative strategies that come to mind. If the problem is an organizational one, compensatory strategies could be used. For instance, the client could be instructed to use visual imagery when listening to discourse so that associations between ideas could be made. However, if the difficulty is an attentional one, then bits of information are being totally missed. It is not a question of whether the information was properly organized and, therefore, more difficult to access. Accessibility is no longer an issue because the information

was not processed in the first place. In that case a form of attentional therapy would be the treatment of choice.

One cannot assume, of course, that a person with an organizational deficit would not benefit from attentional therapy. On the contrary, the attentional requirements would multiply when a person is asked to use an alternate strategy when processing verbal material. Thus, combined with an improvement on attentional measures, there is an expectation that listening comprehension will improve.

Finally, it was a deliberate decision to employ a verbal medium rather than a written one, because listening takes considerably less conscious effort than does silent reading or reading out loud. To reduce the burden in an already stressful testing situation was the primary goal with the addition of this measure.

### **Materials-Computer**

#### **Captain's Log**

Captain's Log is a cognitive training system for use on the microcomputer. This is a comprehensive and versatile rehabilitative programme in that each of the modules within the system can provide stimuli at an individual level. Each module has a similar menu with various options. These module options allow the therapist to select the training mode, level of difficulty, length of task and specific individual features (e.g., distracter stimuli, speed, inhibition).

Each programme has three levels of difficulty: 1) beginner, 2) intermediate, 3) advanced. At the beginner level the subject will experience some initial success. Each level becomes progressively more difficult, requiring cognitive skills to be performed more efficiently.

The purpose of the Attention Skills Module is to enhance the subject's ability to attend, concentrate, and respond appropriately to auditory and visual stimuli for

extended periods of time. This module is comprised of eight programmes.

### **1. Auditory discrimination/rhythm.**

Purpose: To enhance attention and concentration skills and to improve retention, recall, and auditory discrimination of nonverbal stimuli.

This programme requires the subject to attend to two discrete auditory patterns of beeps, compare them and decide whether they are the same or are different. The length of the patterns increase as one progresses from the beginner to the advanced level. The ease or difficulty of the task can be manipulated with features from the programme's menu that affect the feedback, the visual prompts, and the length of the task.

### **2. Auditory discrimination/tones.**

Purpose: To enhance attention and concentration skills and to improve retention, recall, and discrimination of non-verbal stimuli.

This programme requires the subject to attend to two discrete auditory patterns of tones, compare them, and decide whether they are the same or different. The format is similar to the Auditory Discrimination/Rhythm program with the essential difference in the type of auditory stimuli used.

### **3. Colour discrimination/inhibition.**

Purpose: To enhance attention, concentration and discrimination skills which focus on colour and position characteristics of visually presented stimuli and to establish the capacity to inhibit responding when certain characteristics are present.

This programme requires the subject to attend to three coloured figures presented on the screen and to determine whether the center figure is matched in colour by either of the outside figures. As one progresses from the beginner to the advanced level the complexity of the figure changes.

### **4. Scanning reaction/inhibition.**

Purpose: To develop left to right visual scanning ability and discrimination skills which require attention, concentration, judgement, and inhibition.

The programme requires the subject to scan the screen from left to right, top to bottom and respond each time a target appears which is the same colour as the border. As the difficulty level increases, the border will change to any of six different colours, requiring different response sets. Speed of display also increases with the level of difficulty. Thus, as the level of difficulty increases, the rules for responding frequently change, requiring the subject to shift cognitive sets.

### **5. Scanning reaction time.**

Purpose: To develop visual scanning skills and letter/number discrimination abilities.

This programme requires the subject to scan the screen from left to right, top to bottom and to respond each time a target letter or number appears. As one

progresses from beginner to advanced level the speed of display increases. The instructor can also select the allowable response time and variety of stimuli presented.

#### **6. Stimulus reaction/fields.**

Purpose: To develop vigilance and random scanning ability.

This programme requires the subject to scan four quadrants of the screen and move the cursor to the target square whenever it appears in any one of the four quadrants. The target squares become smaller as one progresses from beginner to advanced level. Auditory cues and/or visual distracting stimuli can be selected as program options.

#### **7. Stimulus reaction/inhibition.**

Purpose: To develop attention skills for visual stimuli, visual discrimination, and inhibition.

This programme requires the client to scan the screen and respond each time the target square is the same colour as the border. At the beginner level the border remains one colour. Two colours are used at the intermediate level and any of six colours are used at the advanced level. In addition, the size of the stimuli decrease as the level of difficulty increases. Auditory and/or visual distraction stimuli can be used to increase the difficulty of the task.

#### **8. Stimulus reaction time.**

Purpose: To develop vigilance, rapid scanning ability, and reaction time, and to

develop discrimination and inhibition of response.

This programme requires the subject to scan the screen and respond each time a coloured square appears. As one progresses from beginner to advanced level, the square becomes smaller and the variability between presentations of the coloured square increases. Auditory and/or visual distraction stimuli can be added to increase the task difficulty. For an example of the modules, refer to Appendix N.

### **Design**

The initial baseline measurement was taken, then a second baseline assessment was obtained after a two-week contact period between the researcher and participant. By including the contact period between the researcher and participant, the issue of researcher effect would be minimized. During the two-week period the researcher became actively involved with the participant in a non-attentive task (e.g., going for a walk). At the conclusion of the two-week introduction another set of baseline measures were administered to the participant to ensure that any overall effect was not due to a reaction to the researcher. Then, at two-week intervals following the simple to complex hierarchical arrangement, attention and visuo-perceptual test was administered.

The participant was tested on five out of eight tests repeatedly at two-week intervals. The remaining three measures (reading, self-esteem, and locus of control) were only given at the beginning and at the end of the testing session.

In consideration of fatigue, the attentional and reading measures were administered first, then the personality questionnaires were given at the conclusion of



the testing sessions. Further, on the matter of fatigue, these particular tests were chosen because instructions were simple and concise and the time required to administer the tests was brief.

A potential problem is criterion cheating. This occurs when the testing device is so similar to the task that the skill is developed through practice. The testing instruments that were used in this study do not resemble the computer task. Along with the attentional measures were visuo-perceptual measures to test whether the specific tasks that were administered would generalize across domains.

## **Results**

There are figures to represent each of the test situations mentioned in the result section. Each of the figures will appear subsequent to the relevant discussion.

### **Attentional Measures**

Data for the pilot participant revealed a stable pre-treatment baseline for Stroop scores (see Session 1 and Session 2, Figure 1) and a gradual improvement thereafter (Session 3, 4, 5). The Stroop is a timed outcome measure so that lower scores are associated with improvement.

Tremendous gains were witnessed in the third and most difficult portion of the Stroop (represented in the portion of the graph). The difference score between Session 1 and Session 5 was 31 seconds, an improvement of 30%.

For the Attentional Capacity Test (ACT) a slight increase in scores was noticed following the treatment phase (Time 1 and Time 2 on Figure 2). Upon initiation of

# Stroop

## Colour Word Interference Test

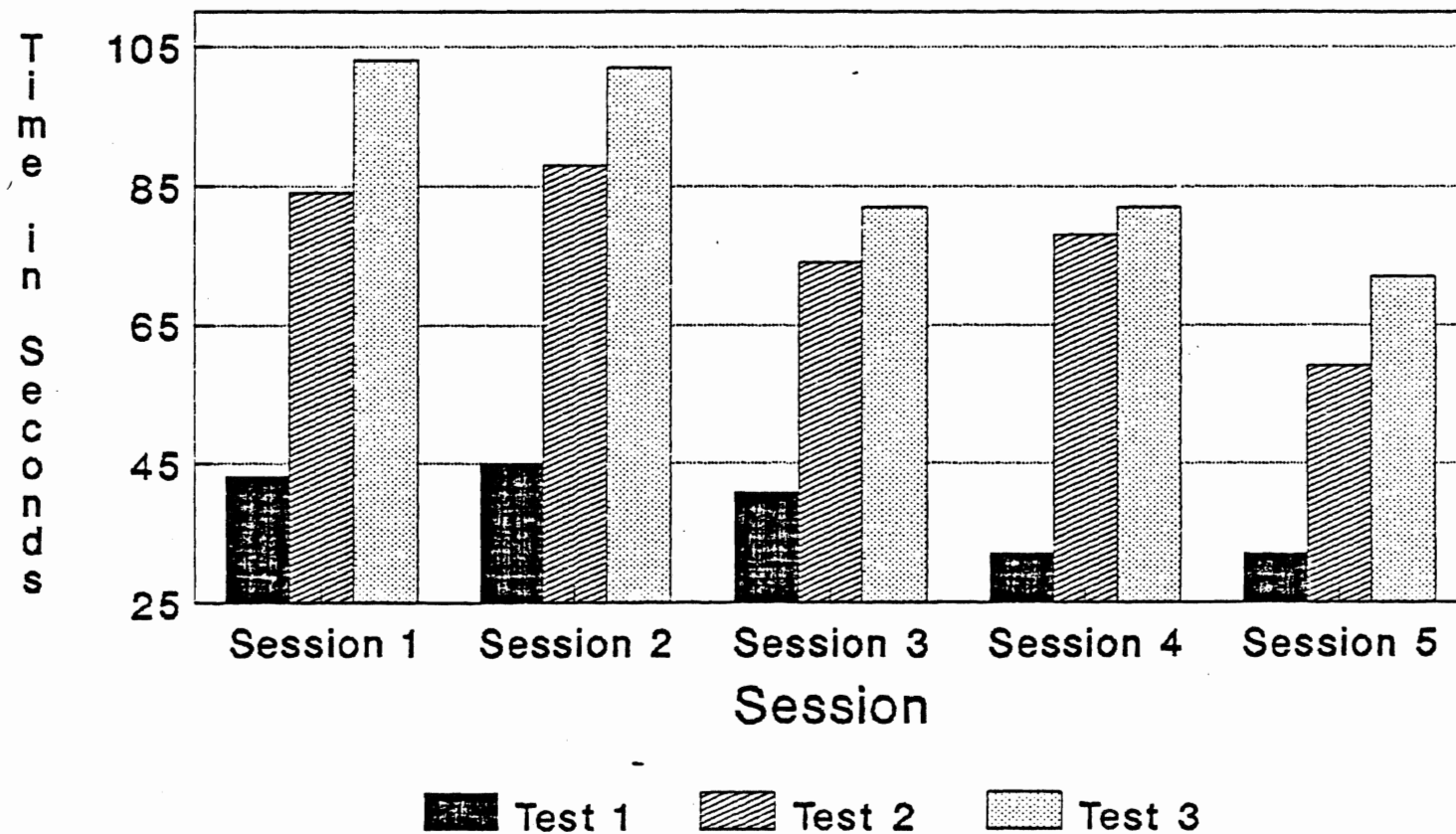


Figure 1. Results for Stroop: Test 1-Colour Identification; 2-Interference; 3-Inhibition over five sessions

# Attentional Capacity (A.C.T.)

31

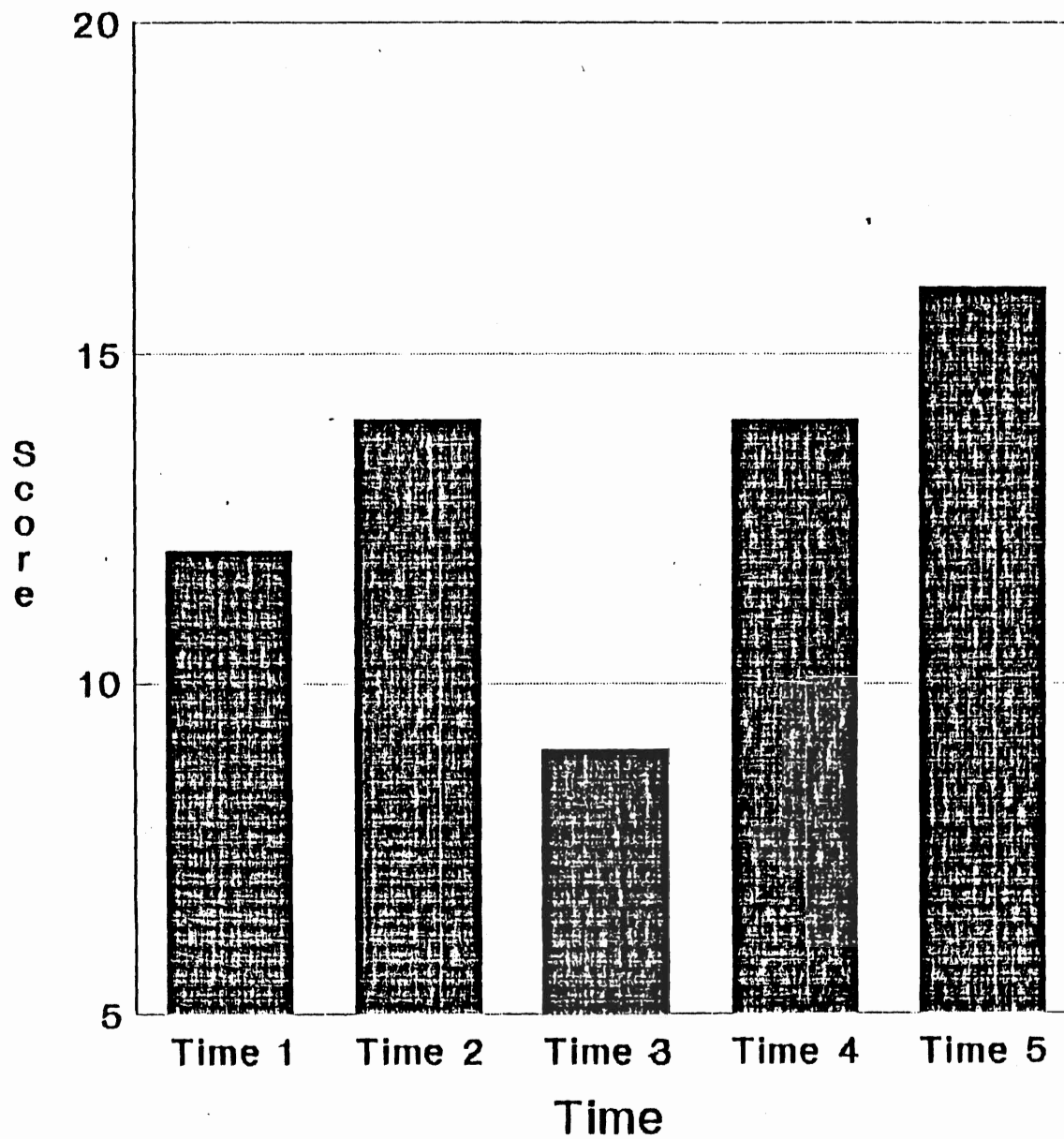


Figure 2. Results for Attentional Capacity Test over five sessions.

attentional therapy at Time 3 the ACT score dropped dramatically due to noise distraction, but thereafter improved gradually. A difference score from Time 1 to Time 5 revealed an improvement of 16.67%.

The Kendrick's (KOLT) was given at pre- and post-treatment phases. There was an improvement of 6 raw score points. Out of a possible score of 70, pre-treatment level was 31 and post-treatment level was 37. Thus, the subject manifested a 19.35% improvement over levels. Interestingly, there were no perseverative errors and just one misnamed object. (See Figure 3).

#### **Durrell Analysis of Reading Difficulty (Durrell)**

There was another test that was included because the subject's deficit was identified specifically to be in the areas of verbal and written instruction. The Durrell was given at both Grade 2 and Grade 6 levels. The purpose of this test is to provide an estimate of the person's listening comprehension capacity as indicated by his or her ability to understand paragraphs that are read aloud by the examiner. At pre-treatment phases the subject clearly had a problem at the Grade 6 level. Out of a possible eight questions, he responded correctly to two. At post-testing he responded correctly to five out of eight questions.

#### **Visuo-Spatial Measures**

On both visuo-spatial measures, Right/Left Discrimination and Judgement of Line Orientation he reached criterion at the pre-treatment phase and continued with an excellent score throughout baseline testing. (See Figure 4).

# Kendrick Object Learning Test

33

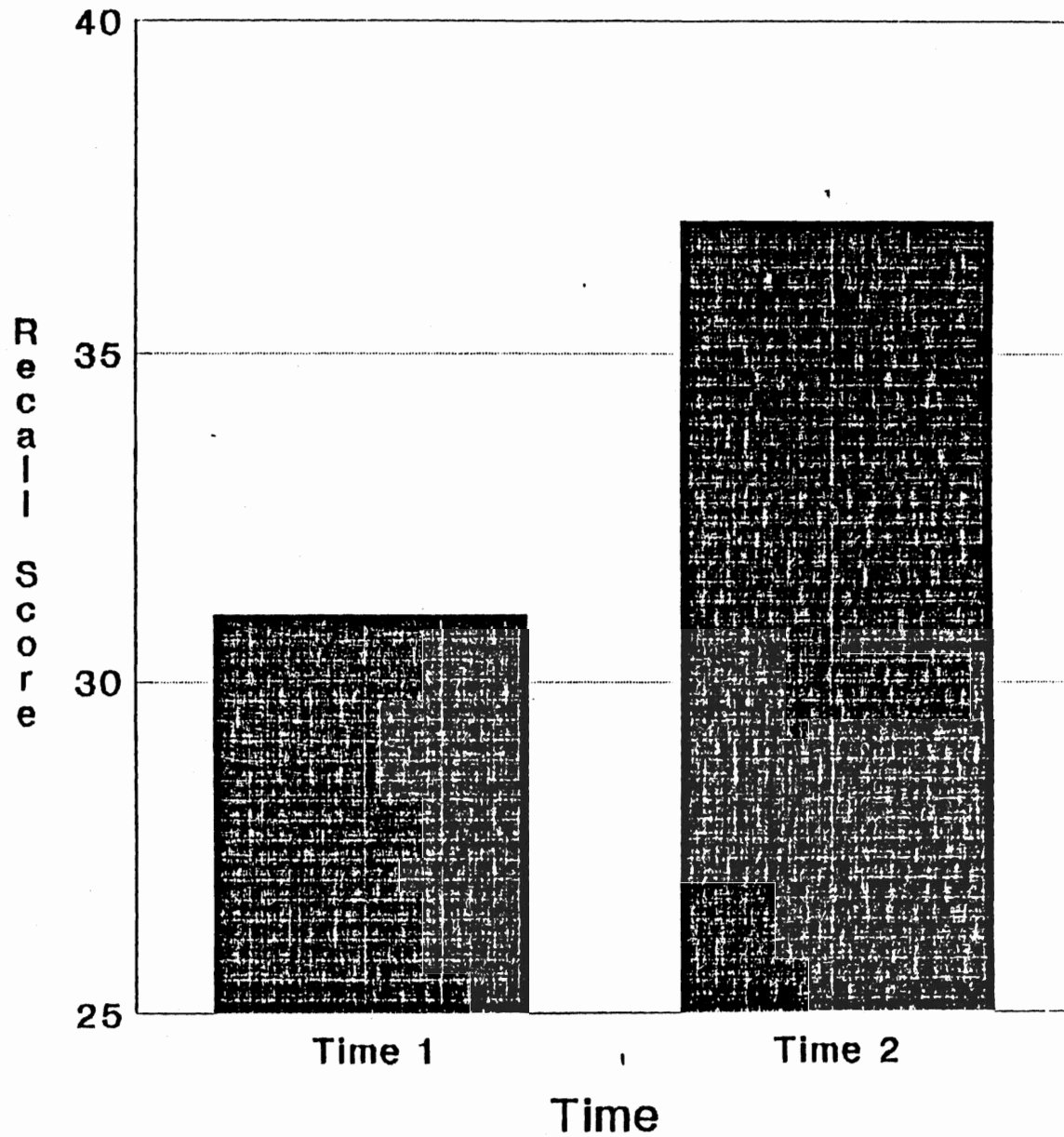


Figure 3. Results for Kendrick's Object Learning Test over two sessions (pre- and post-treatment).

# Right-Left Discrimination

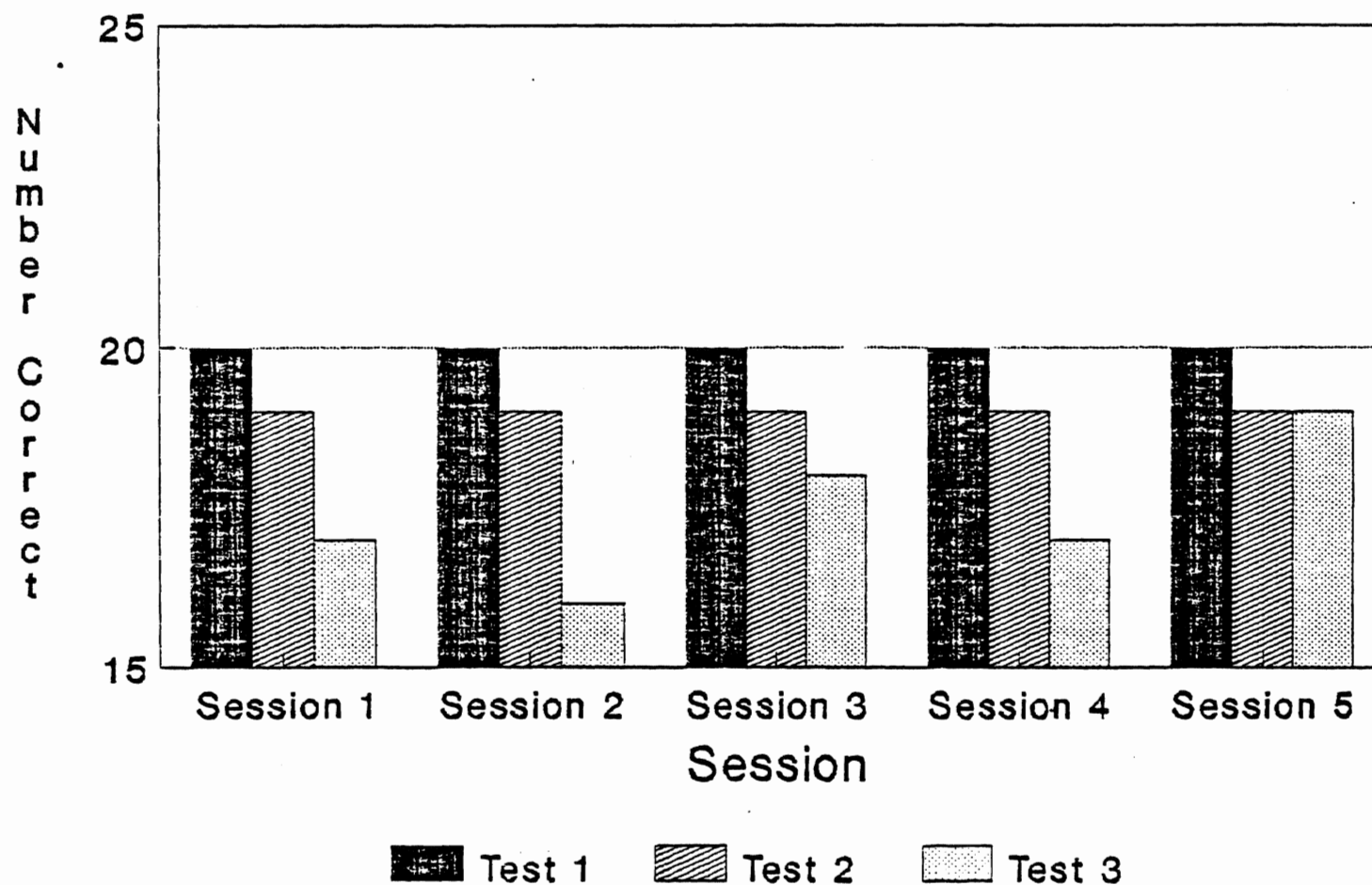


Figure 4. Results of Right-Left Discrimination over five sessions. The scores were consistently within normal levels.

**Index of Self-Esteem (ISE)**

The ISE scale is designed to measure the magnitude of a problem a person has with self-esteem. The ISE has a cutting score of 30 (+ or - 5), with scores above 30 indicating that the respondent has a clinically significant problem and scores below 30 indicating a person has no such problem. On pre-treatment the subject displayed a critical problem with score of 56. At the post-treatment level he registered a marginal problem with a score of 38. (See Figure 5).

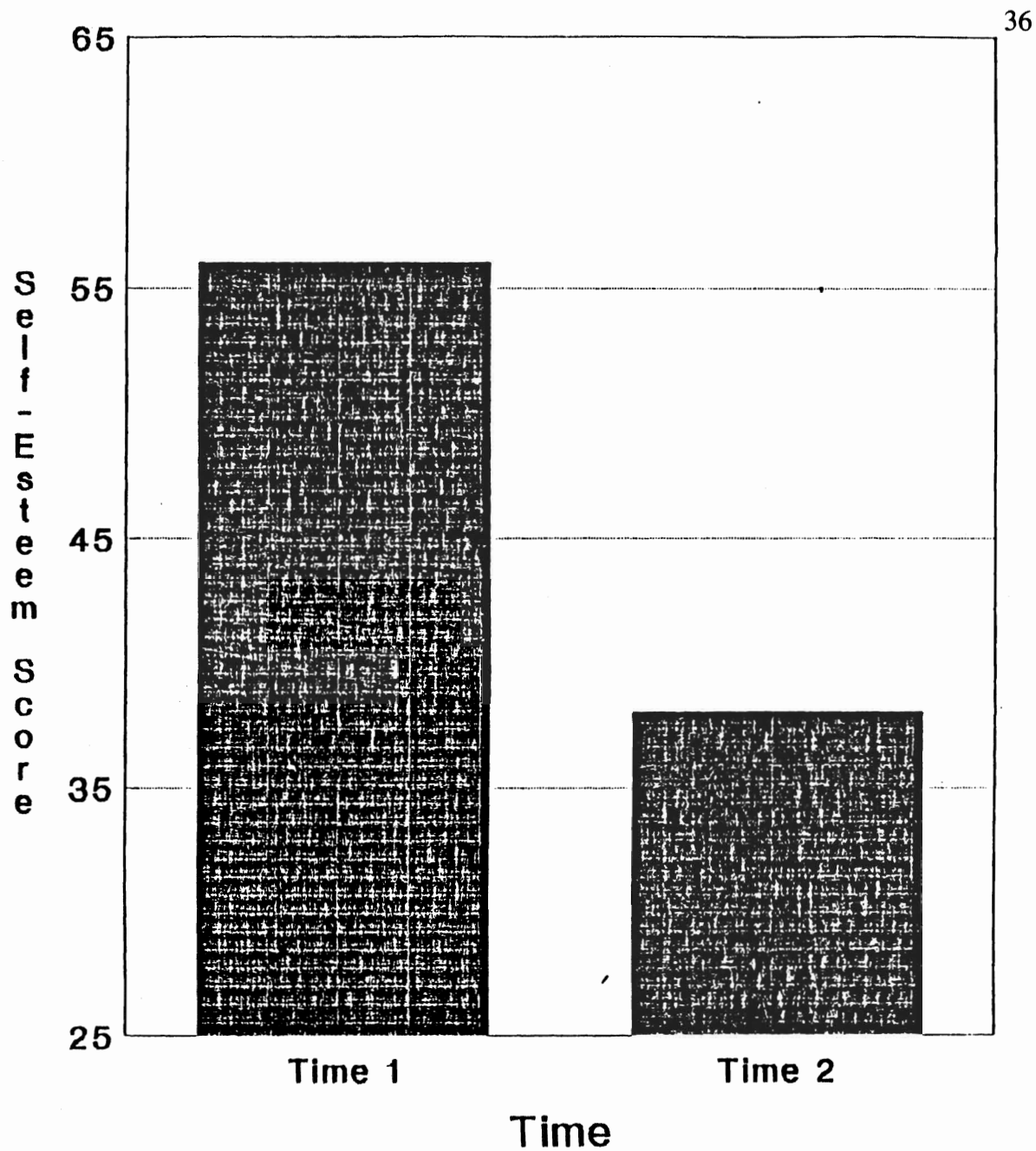
**Locus of Control (LOC)**

The LOC showed similar gains. On the Desire of Outcomes subscale, the participant showed a 10-point difference score (55/65). That is, his desire to control events shifted 18% from externally to internally driven. On the Beliefs and Attitudes subscale, there was a 30- point change. Put another way, he had an attitudinal shift from the external end of the spectrum to the internal end by 28%. (See Figure 6).

**General Functioning Questionnaire**

The General Functioning Questionnaire was given before and after treatment. Unfortunately, there was a delay in the return of post-treatment questionnaire, so it was difficult to determine if there had been any attentional gains as a direct result of the program.

# Self-Esteem



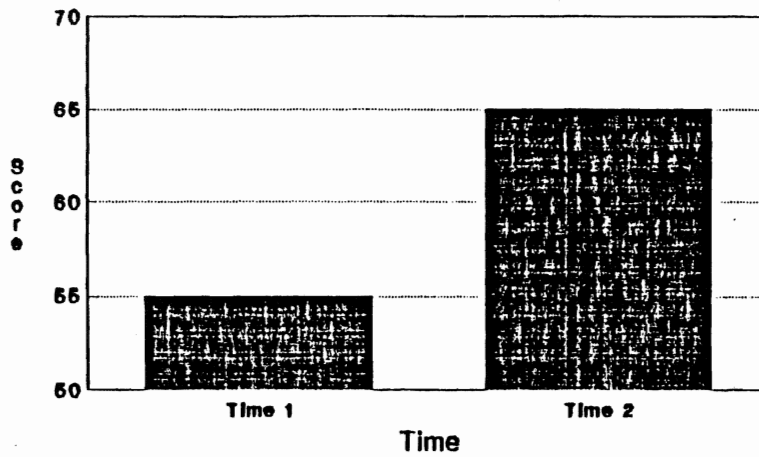
**Note: Lower score = higher self-esteem**

Figure 5. Results of Self-Esteem Index.  
Note, lower scores = higher self-esteem.



## Locus of Control Desired Control Measure

37



## Beliefs and Attitudes

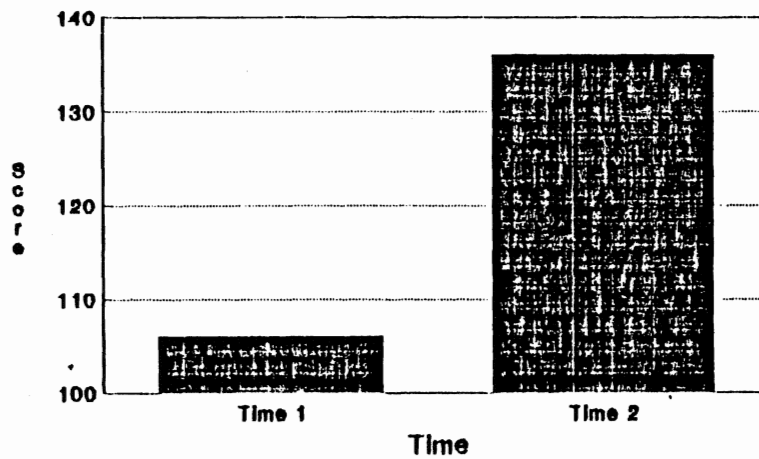


Figure 6. Results for Locus of Control over 2 sessions (pre- and post-treatment)

## Discussion

### General Comments

Although single case evidence must be examined with caution, these pilot data may demonstrate the potential for improvement of attentional deficits after a traumatic head injury. The results may also support the model (hierarchical, beginner to advanced) outlined in the previous segment of the paper.

Some of these measuring devices in Study #1 were given as many as five times over an eight-week period. Without a control group to statistically remove the practice effects one could not be confident that the gains were not as a direct result of familiarity with the task. For this reason, the number of testing sessions was reduced in Study #2. A pre-, interim-, and post-test schedule was adopted at eight-week intervals. This also allowed the researcher to provide a more flexible, personalized computer training format; the participants could advance within the programme at their own speed.

The matter of controls was answered in Study #2 by employing an AB or BA design. That is, the participants acted as their own controls by random alternate assignment to either an AB or BA format. An AB design offers three testing sessions: an eight-week attentional exercise following the pre-test, an eight-week period of no training following the interim-test followed by the post-test. The BA design is similar except that the training and no-training periods were switched. In addition, for those individuals who were assigned to the AB design, it offers the researcher a vehicle to ascertain if there was an extension of the new-learned skill over time.

Inherent to this type of research is the possibility that the participant was reacting to the experimenter and not to the computer task provided. Although there was a period of time set aside between the first and second levels of testing for the researcher and participant to familiarize themselves with each other before treatment was initiated, one still can not totally remove the possibility of the interpersonal interaction affecting the outcome measures. In response to this factor, for Study #2 the counsellors at the Re-Entry Centre assisted with the administration of the attentional computer programme. The researcher had no part in the training sessions, but tested the individuals on a pre-, interim-, post-test basis. The participants were familiar with their case managers so this design improvement reduced the possibility of researcher effects.

Apparently, cyclical personality changes have been noted with regard to the participant in Study #1. Although the actual personality cycle seems to lengthening, it is possible that pre-treatment levels were taken at a very low point and the post-treatment levels at a very high point within the participant's cycle. Individual differences and intervening factors were reduced in Study #2 by the increase in the number of participants.

### **Changes to the Testing Protocol for Study #2 and Interpretation of Results from Study #1**

#### **Stroop**

The Stroop is a timed attentional measure. Each card has a series of 39 black and white or coloured items or words. In Study #1 the researcher allowed the

participant the time to go through each of the 39 items per card. However, it became evident that if a participant were having difficulty within any one of the task components, then the exercise could become laborious. Rather than timing each of the activities to their completion, a prescribed time of 45 seconds was used in the major study to reduce the fatigue factor.

### **Index of Self-Esteem and Locus of Control**

The positive change in ISE and the LOC scores could have been due to reaction to the experimenter or due to the cyclical nature of his personality. However, the success that the participant experienced within the computer program could be considered a contributing factor.

There is one last concern with the LOC test; it is possible for the participant to indicate a response of "undecided" for any or all of the questions. At the post-treatment level the participant did reply in such a fashion for a considerable number of questions. Because of the participant's apparent deficit with written or verbal material, it is possible that he did not understand the questions. In this case, the results would be misleading, the locus shift may be as a result of a compensatory strategy used by him to mislead the experimenter into believing that he understood the material. This test was used again in the new battery for the major study, with the researcher being aware of this potential difficulty.

### **Durrell Analysis of Reading Comprehension**

The identical paragraphs of the Durrell were read aloud in the pre- and post-

sessions. The eight-week time lapse between the sessions was thought to be a sufficient interval to allow the participant to forget the passages. It is not clear whether the improvement in listening-comprehension scores was due to practice effects. In response, a Durrell listening-comprehension test was given at each of the three testing sessions in Study #2, but the presentation began at the Grade One level and proceeded until the participants did not reach criterion. The next session started with the last successful grade level and testing proceeded from that level. Thus, the participants only heard two paragraphs from the preceding testing session (the last successful paragraph and the next paragraph that was failed) and any possible improvement would have to be beyond the last grade level missed.

### **General Functioning Questionnaire**

There is no satisfactory solution that comes to mind regarding the delay in the return of the General Functioning Questionnaire. Because parental involvement is strictly on a volunteer basis, it was impossible to insist on a speedy return. Even after repeated reminders and two telephone calls, the document did not surface. It may be necessary to persuade the caregivers that a hasty reply is needed in order to document meaningful changes in behaviour.

### **Computer System**

The concern over the simple nature of the computer system was unsubstantiated. This highly functioning young adult did find portions of the system difficult. His problem seemed to be in the area of alternating attention. By the introduction of a

more personalized computer training programme (i.e., progressing at one's own speed), the computer arrangement was potentially more challenging.

In summary, there was a positive behavioural change noticed after the initiation of treatment within the pilot investigation. By introducing a personalized training programme, boredom and fatigue levels were reduced. With an increase in the number of experimental participants and the adoption of an AB/BA design, the possibility of practice effects will be minimized. The introduction of this revised testing format should alleviate the problem with movement across the hierarchical levels.

Regarding the battery of testing instruments, Sohlberg and Mateer (1989) found a generalized improvement to memory scores after the attentional retraining, so a minor change to the testing battery was adopted. Two additional memory tests were approved and the Kendrick's attentional measure was dropped. The revised battery had two tests of each - attention, memory, and visuo-spatial; one test of each - reading, self-esteem, locus of control, and general functioning.

## **CHAPTER FOUR: STUDY #2**

On the basis of Study #1, this larger inquiry was undertaken. The modifications to Study #2 were outlined in the last section, but the major changes will be briefly mentioned again as the text proceeds. Before advancing directly into the description of the participants, materials and design, there is an issue regarding case studies that requires some attention.

### **Single-Case Studies**

In psychological research, the usual manner of illustrating significant alterations involves analysis of group statistics. However, Caramazza (1986) asserts that this approach is often not satisfactory for examining the changes in cognitive processes because statistical manipulation of group data is likely to obscure changes in individual functioning. He believes that this is particularly true for populations which present as much diversity in degree and nature of cognitive disability as brain-damaged individuals. His argument concerns characteristics of the subject population; more precisely, subjects should meet conditions of uniformity. In other words, by violating the homogeneity condition of subject populations it renders the inferential status of patient group studies either wrong or "trivial." From Caramazza's standpoint, only intensive single-case studies allow valid inferences about normal cognitive process from analysis of pathological disorders. In that vein, the selection of single-case studies to investigate the efficacy of a computer-based remediation tool for the head injured was influenced by Caramazza's assertions. However, to evaluate improvement over time and practice effects group statistics were performed and will

be presented following the case studies.

### **Hypotheses**

Here, as well as in Study #1 the question of interest was whether the Captain's Log Computer System effectively remediates the attentional skills of a person who has sustained a brain injury. There are six hypotheses:

1. The participants will demonstrate an increase in scores on attentional measures (ACT, STROOP) compared to pre-test levels. A change will be demonstrated after the participants experience the treatment phase, and for those assigned to the AB format those positive changes will endure to post-testing. This general improvement will occur as a result of exposure to complex, domain specific stimuli.
2. Gains in attentional scores will generalize to improve memory capacity (Randt, Memory Paragraphs).
3. Improvement of attention skill will be reflected in an advancement in grade level for listening comprehension. As attentional capacity is enhanced, so will ability to attend to verbal material and the ability to answer questions pertaining to the verbal material.
4. Self-esteem and Locus-of-Control scores will improve as measured by the ISE and LOC. Scores are anticipated to reveal a positive change because of a sense of accomplishment with an improvement in attentional skills.
5. Reports of level of functioning in living and learning environments will improve compared to pre-treatment reports as measured by the General Functioning Questionnaire. The improved attentional skills will have a positive effect because



distractability and confusion will be lessened and the individuals will be better equipped to deal with their everyday living.

6. The participants will demonstrate little advancement or perform within normal levels (considering the results of Study #1) in visuo-spatial scores (JOLO, Rt/Lt Discrimination) compared to pre-treatment scores. There is no expectation that acquired attentional skill will generalize to visuo-spatial scores because of the specific nature of the tasks.

## **Method**

### **Participants**

Five head-injured males enrolled in a re-entry programme served as voluntary participants. This male sample is representative of the general population, as the majority of trauma-related injuries occur to young, adult males. There was no payment for participation but transportation to the centre was provided when necessary.

This was a voluntary assignment within the Re-Entry programme. Participants were advised that they could choose to leave the study at any time, without an explanation. For a sample of the Consent Form, please see Appendix A.

To be considered for this project, candidates: (i) had to have the use of a least one upper limb so that they could manipulate the computer mouse and, (ii) would not suffer from a visual or auditory problem due to the nature of the computer tasks. In addition, participants had to exhibit an attentional disorder in the form of distractability, as reported by staff at the Re-Entry Centre and exhibit a

quantifiable deficit by way of previously measured attentional scores (Trail Making- See Appendix K). What will follow is a brief description and results of the Trail Making Test (Lezak, 1976), the measure that was used as an indicator of an attentional deficit.

### **The Trail Making Test**

In practice it is difficult to devise a test which identifies attentional capacity separate from other components such as concentration, tracking, and even memory. Most tests of attention and concentration involve some tracking, either mental or perceptual, and often involve some scanning. The more complicated tracking tests involve multiple tracking abilities, such as the ability to keep track of two stimuli or lines of thought simultaneously, alternatively, or sequentially. The capacity for multiple tracking is one of the first, and the one most likely to break down after brain damage. On occasion, it may be the only documentable change following a head injury. Nonetheless, it is important to observe the patient's overall behaviour and test performance in order to distinguish global attentional problems from those of concentration and tracking. It is also important to note that not all attentional problems are global in nature, but may be specific to a certain modality (i.e., visual or verbal) (Diller & Weinberg, 1972).

Trail Making is a two-part test which involves both simple and dual tracking abilities and is part of the Halstead-Reitan Test Battery (Reitan, 1958). Part A of the test involves connecting consecutively numbered circles with a continuous line, whereas Part B of the test involves connecting a series of consecutively numbered and

lettered circles, alternating between a number and a letter. Both time and number of errors are scored, although in a normal population, errors are not generally recorded on this test. It is an attentional function task that is very sensitive to the effects of brain injury. As a timed test, it is also sensitive to response speeds, and as could be expected, performance time increases with age. Normative values have been obtained for different sexes and age groups.

All participants in this study were administered the Trail Making Test prior to their inclusion in this attentional programme. Four of the five participants (Aa, Bb, Da, and Ea) committed errors on Part B and scored below the 25th percentile for their respective age group. The fifth participant, (Cb) scored below the 50th percentile on Part B and was 1.5 S.D. below the mean for his age group. On the basis of the task, it seems likely that at least four volunteers have moderate to severe attentional problems, while the fifth may be experiencing some mild impairment of attentional processes. Motor difficulties were not a factor with any of the participants.

### **Materials-Testing Measures**

There was a slight modification to the testing battery so that a memory component could be represented. The Kendrick's Attentional Test was dropped and there was the addition of two memory measures: 1. Memory Paragraphs, and 2. Randt Memory Test. The balance of the battery remained the same as for Study #1. For a description of the original tests please refer to the previous study (STROOP, ACT, ISE, LOC, JOLO, Rt/Lt Discrimination, Durrell, and General Functioning).

The two additional memory measures will be discussed here.

### **Memory Paragraphs**

The Memory Paragraphs were selected from The Wechsler Memory Scale-Revised (Wechsler, 1987). Paragraphs with 26 segments of information were read to the participants. They were asked to listen carefully and remember the passage just the way it was read to them. It was explained to them that at the conclusion of the paragraph they would be asked to remember and repeat everything that was read.

Three paragraphs, one for each testing session were chosen. However, one paragraph required a change to the content because it seemed outdated and inappropriate for this particular audience. A list of scoring criteria was provided for the three paragraphs. The criteria gave a general rule to follow and examples of 1-point and 0-point responses. Following the participants' responses, the words and phrases were compared to the scoring criteria. (See Appendix L).

### **Randt Memory Test (Randt, & Brown, 1986)**

The Randt Memory Test consisting of seven modules is designed to measure memory function over a broad spectrum of mild to moderate deficits. This test battery has been shown to be a sensitive and reliable measure of important aspects of memory. From the seven modules, three were chosen to represent the memory component. What will follow is a brief description of the three modules used for Study #2.

**Module 1 - Five items.**

Five monosyllabic nouns with high concrete imagery comprise this learning task. Five Items is a list learning task in which the participant is orally presented with just five verbal items (e.g., rain, skirt, sky, car, dog) which he/she is asked to commit to memory. Participants are given up to three trials to acquire these items, each trial being separated by a 10-second period of subtraction. Participants were advised that they will be asked to recall the five items later in the test.

**Module 2 - Paired words.**

Paired Words is a paired associate task in which the participant is orally presented with a total of six word pairs with varying degrees of relatedness. The participant was asked to commit these paired words to memory, with the instruction that he/she would be asked to repeat the second word in the pair after the first word was presented. Participants were given up to three trials to acquire the paired words, each trial was separated by a ten-second subtraction task. They were told that they would be asked to recall the second word in the pairs later in the testing.

**Module 3 - Picture recognition.**

This picture recognition and recall task is designed to assess both immediate and long-delayed recognition of line drawings and common objects as well as delayed verbal recall of the same pictures. Participants were told they would be shown a set of pictures which they were to remember. Immediately following the exposure, they were asked to identify the pictures in the first set from a larger group of pictures.

They were told that they would be asked to recognize the same set of prints later in the test.

There are several sets of each of these modules so that a different set was used at each testing session to minimize practice effects. It must be noted that there was a 24-hour recall component to these modules that would normally be administered the following day. Because all of these individuals were scheduled into the day programme, tri-weekly, it was impossible to routinely contact them the next day, so this 24-hour component was dropped from the battery. In this way, the test was administered with a non-standard procedure. (See Appendix M).

### **Materials-Computer**

The Captain's Log system was described in Study #1.

### **Design**

A multiple baseline for measures was necessary in order to show a dissociation of newly learned skills. That is, if one is specifically training attention, there was no expectation that the training would influence separate measures, such as those tapping visuo-spatial skills. Secondly, it was important to gain a better understanding of the deficits existing after brain injury prior to treatment.

Each of five participants received the same testing schedule and was alternately assigned to either an AB or a BA design. The AB pattern featured a pre-test followed by a eight-week period of attentional computer training, then interim-testing followed by an eight-week period of no computer training, then the post-test. In the second

assignment the computer task session and the no-task session were reversed.

### **AB Assignment**

Pre-Test \* Computer \* Interim-Test \* No Computer \* Post-Test

### **BA Assignment**

Pre-Test \* No Computer \* Interim-Test \* Computer \* Post-Test

All three of the baseline testing phases included two measures of attention, memory, and visuo-spatial and one measure of reading ability, self-esteem, and locus of control. Further, legal guardians were asked to complete a questionnaire regarding general functioning at the beginning and the conclusion of the study.

The participants were required to spend a minimum of four hours per week in the Captain's Log System. It was necessary to adopt a flexible schedule due to a transportation problem and due to a possible inability to attend the day sessions due to illness.

## **Results**

Each participant will be distinguished by an upper case letter-A, B, C, D, and E. Further, according to which format was alternately assigned, they will be given a lower case letter. For example, if participant-A were designated to take part in AB design format, he would be appointed participant Aa; if participant-C took part in BA design format, he would be appointed the title Cb. This will allow the reader to easily identify participant and format, and at the same time will maintain

confidentiality. Summary Table 1 is located at the conclusion of the result section.

As mentioned earlier, the testing schedule was altered from the first study. Instead of measuring performance on a two-week basis, the format was changed to a pre-, interim-, and post-test, flexible, eight-week programme.

The Stroop scores were formulated differently for Study #2 compared to Study #1. In the first inquiry, time to complete the task was represented as scores, so a lower score meant that there was an improvement in performance. However, in this study the participants were given 45 seconds to complete each section of the Stroop. Therefore, scores were represented as items identified correctly, an improvement would be represented by a higher number of correct decisions. In addition, as previously explained, the participants were only presented with 39 items as compared to 112 items presented under normal conditions.

The subsequent section of text is allotted to a presentation of the results on an individual basis (Participants Aa, Bb, Cb, Da, and Ea). Regardless of outcome, each of the measures will be discussed. Please note that a number of the testing instruments required slight modification due to the nature of the subject population, so that S.D.'s were not always available. To maintain confidentiality, only a brief history of each participant will be offered. Refer to Table 1 at the end of the result section for a summary of the scores with the exception of the visuo-spatial scores which are presented later in the paper as Table 2. Group analyses will follow the results of the case studies.



**Participant Aa**

This volunteer presented with a problem in verbal comprehension ability and a moderate distractability difficulty. He also experienced severe psycho-social problems in the form of aggression. He is presently 43 years of age, with a delay of systematic, cognitive treatment of 33 years.

Both attentional measures showed some improvement following treatment sessions. The moderate improvement on the ACT from pre-test to interim-testing did not endure to the post-testing (11-13-11). At pre-testing he recorded 3.4 S.D. below the adult mean and after treatment he achieved a score that was 2 S.D. below the adult norm. However, any improvement was lost at post-testing when he returned to baseline levels. Considerable gains were made in the third and most difficult portion of the Stroop (Inhibition portion). The difference score between pre- and interim-testing was 7 points, an improvement of 87.5%, but at post-testing he dropped back to an improvement of 50%.

Likewise, the Memory Paragraphs yielded the same type of results, the difference scores between pre- and interim-testing were substantial (36%) but the improvement did not endure to post-testing levels where the participant fell slightly below initial levels. There was no improvement noted on any of the modules within the Randt Memory Test.

The Durrell certainly did not reflect attentional scores as predicted, and in fact showed an inverse relationship. There was little improvement following treatment; however, the increased scores came at post-testing after a period of no treatment, unlike the attentional results, moving from a grade level of 2 to 3 and then to 6.

The Index of Self-Esteem (ISE) scale is designed to measure the magnitude of a problem a person may have with self-esteem. The ISE has a cutting score of 30 (+ or - 5), with scores above 30 indicating that the respondent has a clinically significant problem and scores below 30 indicating no such problem. This participant maintained a clinically significant problem throughout all testing sessions (55-61-61).

The Locus of Control showed consistent gains across testing sessions. He demonstrated similar gains on both subscales- Desired Control (70-76-78) and Beliefs and Attitudes (105-130-151). The Beliefs and Attitudes Subscale showed the greatest difference score of 46 points. In other words, he had an attitudinal shift from the external end of the continuum to the internal end by 44%.

Both visuo-spatial measures displayed small gains, but there was no pattern that emerged because he was within the normal range for all testing sessions. In a personal communication, B. Kolb (May, 1991) indicated that a total score on Rt/Lt Discrimination that was greater than 50 would manifest a normal performance. Participant Aa scored above that mark at all sessions (53-56-52). Likewise, JOLO produced scores within the low average to average range (Benton, Hamsher, Varney, & Spreen, 1983). For scores and corresponding percentile ranks for the JOLO, see Table 2 at the end of this section.

The General Functioning Questionnaire was completed by his father, who sees him on a regular basis. He reports some inconsistency in his attentional behaviour; "His attention is better sometimes than others." However, his father goes on to report that his attention to or awareness of his social inadequacies seemed to be heightened after treatment; " He appears to becoming more distressed about his behaviour."

Although the improvement scores were scattered, perhaps his father puts it the best when he relates some of his concerns: "Considering it was so long ago that he was injured (30 years +), rehabilitation for traumatic brain injured was unheard of, and the long years in an institution where he was considered slightly better than a vegetable, really any improvements at this point are a plus."

### **Participant Bb**

This 50-year-old volunteer has lived with his mother since the date of the trauma, 19 years ago. He is reported as being easily distracted, but that his attention is linked with his interest on the topic. This individual was assigned to the BA (b) design format so the treatment phase occurs after the interim-testing session.

Both attention tests measured considerable gains only after the treatment phase. The ACT revealed no improvement from pre- to interim-testing; however, following the treatment phase there was an improvement of 4 points (14- 14-18), that translates into a difference score of 29%, to within 1 S.D. of the adult mean. The Inhibition (24-28-31) subscale of the Stroop revealed a slight gain after the treatment phase.

There was no appreciable gain on either of the memory measurements. The Durrell showed similar consistent results (5-5-5).

While the Index of Self-Esteem did not fluctuate more than a few points, he maintained a moderate problem with self-esteem throughout the testing schedule. Both the Locus of Control subscales were consistent across all phases.

The visuo-spatial testing presented no change across the three testing sessions, but he was within normal levels at all testing sessions. The same holds for the General

Functioning Questionnaire; there were no noticeable changes following the treatment phase as reported by his mother.

### **Participant Cb**

The individual lives independently from his parents in a supervised living environment. He sustained a head injury at the age of 10, and has been in and out of rehabilitation, integration programmes for 12 years. His problems lie in the area of distractability and awareness of social cues. Although, his scores on the Trial Making Test registered only a mild impairment of attentional process, the clinically controlled environment could have been a relevant factor in his performance.

There was no change in the ACT (always 1 S.D. below the adult mean); however, there was a moderate positive change in the Interference (31-33-38) and Inhibition (33-35-37) portions of the Stroop.

There was no loss or gain experienced within the two memory appraisals. The Memory Paragraphs and the Randt showed consistent results between interim- and post- testing. Likewise, listening comprehension showed no appreciable gains, as measured by the Durrell.

The ISE registered a moderate problem at interim- testing with a score of 41; the problem worsened at post-testing with a tally of 47. Likewise, both of the LOC control measures exhibited a slight shift to an external locus. The Desired Control (76-78-75)) and the Beliefs and Attitudes (124-152-134) scales fluctuated in a way that represent a personal conflict that the participant was experiencing over the 16-week period. At that time, he was struggling with some confinement and independence

issues that were later resolved.

The visuo-spatial scores revealed average levels. The slight improvement (52-48-57) that was noted from interim- to post-testing on the Rt/Lt Discrimination may be more indicative of his mood than his ability, because at the interim-testing session he seemed in a great hurry to complete the task and totally bored, refusing instruction at the beginning of each test.

As a joint effort, both parents filled out the General Functioning Questionnaires relating no apparent improvement in his attentional capacity. Both parents take an active role in their son's life and believe that for their son to realize independence he must continue in the rehabilitation process.

### **Participant Da**

This participant has been reported as being easily distracted with problems in the area of verbal and visual comprehension. He is 46 years of age and sustained a head injury eight years ago. At the moment, he lives independently in a wheelchair-accessible condominium.

The attentional measures showed contradictory results. After treatment, the ACT score depreciated by 3 points (15-12-13). That translates into a loss of 1.2 S.D. between pre- and interim-testing. However, the Inhibition subtest of the Stroop, the most difficult portion, registered an improvement over time (21-24-27).

Both of the memory tests showed consistent scores across all trials. Similarly, the Durrell showed no appreciable gains (Grade 3, Grade 3, Grade 5).

The ISE registered some fluctuation, but all scores indicated there was a problem

in the area of self-esteem (42-47-45). The Beliefs and Attitudes sub-test of the LOC demonstrated a major shift to the external extreme of the control continuum (145-117-109). In other words, there was a shift to the external by 19% after treatment, and another 6.8% move from interim- to post-testing. This may be due to circumstances rather than a locus swing. During that 16- week period transportation presented a problem. In one instance, he was picked up at his home and driven to a destination 30 miles away for computer training; the participant told the driver that it was not the intended stop, but the driver insisted and took him to the wrong destination anyway. At the same time his electric wheelchair needed repair, he was left with a manual, auxiliary chair that could not manoeuvre over the barriers at his doorways; thus, he was confined to his home if there were no one to assist him.

On visuo-spatial measures he consistently scored within the average levels on both JOLO and Rt/Lt Discrimination.

The General Functioning Questionnaire was completed by his mother, who sees him periodically. She reported no change in his behaviour.

### **Participant Ea**

As reported by the staff at the Re-entry Centre, this participant experiences problems in the following areas: 1) perception of psycho-social cues; 2) verbal fluency; 3) distractability; and 4) memory. He is 30 years old and sustained his injury two years earlier.

The ACT demonstrated fluctuations over the three sessions (14-9-16); there was a loss of 2.2 S.D. after treatment, but levels were superior to baseline measures by .8

S.D. at post-testing. The Interference portion of the Stroop showed 40% gain after treatment (20-28-26). The Inhibition portion revealed consistent gains over time (21-23-24).

The scores from the Memory Paragraphs (1-0-4) were extremely low. The participant had a difficult time remembering any details of a paragraph read to him only seconds before. He was given a considerable amount of time to come up with a reply, but time did not seem to be a factor. In fact, as the time allowed proceeded he would become very agitated and he would experience tremors of his upper body. To reduce his agitation, a change in topic or surrounding was all that was necessary.

The Paired Word-Recall (1-6-14) and the Picture Recognition-Acquisition (10-13-14) portions of the Randt Memory Test indicated a positive change. Again, time allowed did not account for any improvement in scores. Paired Word-Recall requires the person to respond to a key word with a paired word that was provided several times before a brief delay. At initial testing the participant could only identify one associated word, even after three presentations. Out of a possible 18 points across three trials, he still could only identify six words at interim-testing. The number improved to 14/18 at post-testing. At final testing he seemed more confident about his answers (in the other testing situations he would answer incorrectly, repeatedly) and a lot less confused.

The Durrell improved, but this improvement may be due to practice effects (Grade 0, Grade 1, Grade 3). At Grade Level One the paragraph presentation is about a cat and at Grade Level Two the paragraph is about a dog. He would confuse the subject matter in the two stories and substitute cat for dog. At the final testing

session he was more successful in discriminating between the subject matter.

As mentioned previously, the ISE has a Cutting score of 30 (+ or - 5), with scores above 30 indicating a problem and those above 30 indicating no problem. On pre-treatment the participant displayed a moderate problem with a score of 41. After treatment he registered a marginal problem at 38.

The LOC exhibited similar gains. On the Beliefs and Attitudes subtest, he registered a 17-point gain from pre- to interim testing, and continued to show improvement at post-testing (133-150-157). This means that there was a 12% attitudinal shift from the external to the internal end of the spectrum. This may be due to circumstances at the time of testing. He had moved from his parents' home to an independant living situation.

Both the visuo-spatial measures reflected a range of normal functioning. There was no hesitation, and self-correcting was minimal on both the JOLO and Rt/Lt Discrimination. In fact, the final score on the Rt/Lt discrimination was nearly perfect, 59 out of a possible score of 60. He went from an average score (51), to a high average (56) at interim-testing, to an almost perfect score. The General Functioning Questionnaire was completed by his father. Although exposure to his son had decreased because of the change in living situation, his father continued to drive his son to and from the centre at the final stage of testing. He reported that he had noticed a change in the area of confusion. It seems the father finds conversations much easier. That report would seem to mirror the qualifying statements that were offered in the discussion of the Randt and Durrell results.

Table 1 is a summary of all the raw data scores, except the visuo-spatial results.



Table 1: Summary Table

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Partic	Aa	Da	Ea	Bb	Cb
ACT	11-13-11	15-12-13	14-09-16	14-14-18	16-17-16
Stroop					
Inter	12-12-14	19-17-23	20-28-26	24-27-26	31-33-38
Inhib	08-15-12	21-24-27	21-23-24	24-28-31	33-35-37
Randt 5 items					
Acquis	12-12-14	08-08-09	08-06-06	15-15-14	07-14-14
Delay	03-03-05	01-04-00	00-01-02	01-03-04	03-03-05
Recall	14-14-15	15-14-11	03-08-06	14-15-15	15-15-15
Paired Words					
Acquis	17-11-16	06-06-10	03-05-05	17-13-16	14-10-13
Delay	06-05-06	04-04-00	02-02-03	05-05-06	05-05-06
Recall	18-18-18	13-12-14	00-06-14	18-18-18	18-18-15
Picture Recog					
Acquis	15-15-15	15-15-15	12-15-13	15-15-15	15-15-15
Delay	15-15-15	15-15-14	12-15-13	15-15-15	15-14-15
Recall	02-02-02	05-06-04	01-03-02	06-05-05	04-04-06
Memory Paragraphs					
	11-15-10	08-07-07	01-00-04	16-10-15	12-09-08
Durrell					
	02-03-06	03-03-05	00-01-03	05-05-05	02-05-06
LOC					
Control	70-76-78	76-79-74	65-67-74	71-73-74	76-78-75
B&A	105-130-151	145-117-109	133-150-157	96-98-102	124-152-134
ISE	55-61-61	42-47-45	41-38-37	47-44-46	41-41-47

\*\* Partic = Participants, Inter = Interference, Inhib = Inhibition, Acquis = Acquisition, Delay = After a delay, Control = Desired Control, B&A = Beliefs and Attitudes

**Table 2: Visuo-Spatial Results**

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**Judgement of Line Orientation: Percentiles**

Score	%ile	Rank
29-30	+86	Superior
27-28	72	High-Average*
25-26	56	Average*
23-24	40	Average*
21-22	22	Low-Average*
19-20	9	Borderline
17-18	4	Moderate Deficit
>17	1.5	Severe Deficit

**Values for Participants**

Participant	Scores
Aa	21-23-25
Bb	22-23-24
Cb	25-28-25
Da	25-25-23
Ea	21-26-23

**\*\* All participants scored within the low-average, average, or high average range.**

Note the changes at the interference and inhibition levels of the Stroop over time.

### Group Analyses

If any one of the measures demonstrated an incremental positive change from pre-treatment levels, analyses were performed to identify whether that change improved significantly over time and whether the change was significantly associated with treatment. The data from the Interference and Inhibition portions of the Stroop, the Durrell, the ACT, the Beliefs and Attitudes portion of LOC, and the ISE were analyzed with a 2 x 3 (Group x Testing phase) repeated measures analysis of variance. The Group variable represents the order assignment (treatment first versus no treatment first), the Testing variable represents the 3 phases of testing, and the interaction represents the effect of treatment versus no treatment on change scores. For the Interference portion of the Stroop, there was a nonsignificant trend in the main effect of Testing over time,  $F(2, 6) = 3.08$ ,  $p = .120$ , and no significant interaction,  $F(2, 6) = .01$ ,  $p = .986$ . For the Inhibition portion of the Stroop, there was a significant main effect,  $F(2, 6) = 12.48$ ,  $p = .007$ , indicating a positive improvement over time. There was no significant interaction,  $F(2, 6) = .57$ ,  $p = .592$ . Thus, there was no significant improvement as a function of treatment. Figure 7 illustrates the change over time for both treatment and no-treatment periods for these two measures.

The Durrell showed some improvement over time,  $F(2, 6) = 8.31$ ,  $p = .019$ . However, there was no significant interaction,  $F(2, 6) = 1.11$ ,  $p = 3.88$ . This demonstrates that the improvement was not due to treatment.

# Stroop Test Performance

## Interference & Inhibition over Time

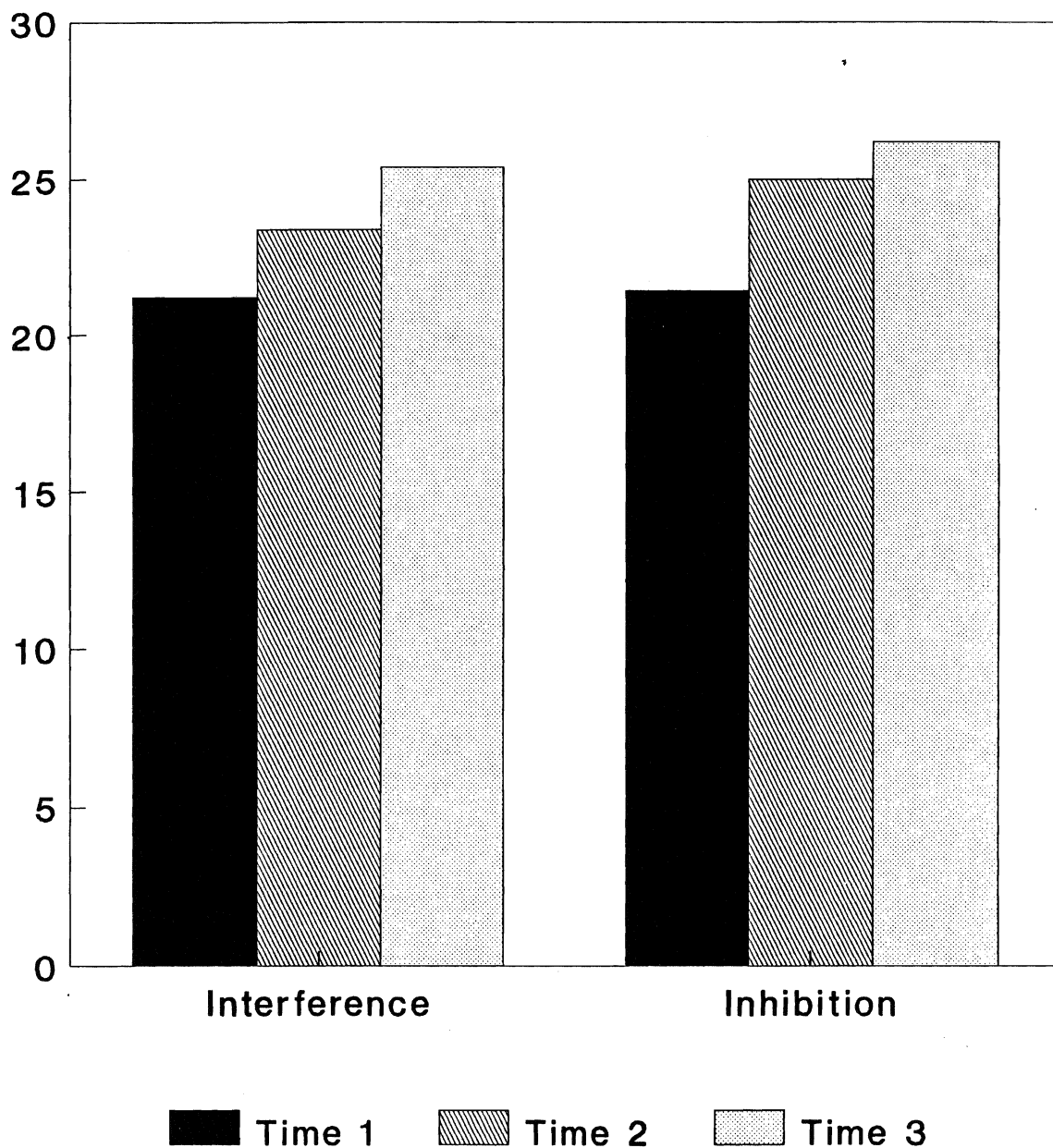


Figure 7. Interference and Inhibition Portions of the Stroop Over Time.

The ACT, Beliefs and Attitudes portion of the LOC, and the ISE demonstrated no improvement over time and no interaction,  $F(2, 6) = .69, 1.43, \text{ and } .71$ , respectively, all n.s.

## **CHAPTER FIVE: DISCUSSION, IMPLICATIONS, AND RESEARCH LIMITATIONS**

### **Discussion**

The data do not support the effectiveness of the computer training in remediating attentional deficits in a group of survivors of brain injury. The participants showed little response in terms of the dependent measures used. The analysis on the ACT, the Interference portion of the Stroop, the Beliefs and Attitudes subtest of LOC, and the ISE showed no improvement over time and no improvement as a result of treatment. The Inhibition portion of the Stroop (see Figure 7) and the Durrell demonstrated an improvement over time but the improvement was not due to treatment. Any improvement manifested in the Inhibition portion of the Stroop and the Durrell could be attributed to practice effects.

Although the group analyses did not support the effectiveness of the computer system, these analyses do support this type of design. There is a definite need for a pre-treatment baseline and a period of no intervention when conducting an outcome study. Without a no-treatment period, one runs the danger of interpreting any positive gains as indicating that the intervention is successful.

When one statistically examines data, there is always a possibility of obscuring individual differences. It seems that just as the clinical presentation of the brain injured is heterogenous, so are the individual results of this study. What will follow is my response to the predictions generated from the hypotheses and a brief description of the individual differences with regard to the dependent measures.

The expectation that attentional measures would improve did occur in certain cases. In contrast to the Inhibition portion of the Stroop where all participants improved after treatment, there was improvement on the ACT for only two members of the group and on the Interference portion of the Stroop also for two others. Specifically, the greatest increment of change was noticed for Bb in ACT and for Ea in Interference after treatment (See Table 1).

The prediction that attentional gains would generalize to memory outcomes did not surface. There was little or no consistent improvement across the attention and memory tests for all the participants, with one exception. Participant Ea did very well on certain portions of the Randt. His confidence and confusion levels seemed to improve. Consideration may have to be given to the fact that the initial scores were extremely low, and that this participant was just two years post-trauma, compared to the long delays experienced by the other participants (8, 10, 19 and 33 years).

There was an expectation that an improvement in attentional skill would be reflected in an advancement in grade level for listening comprehension. Listening comprehension as measured by the Durrell did not reflect any improvement after treatment. In fact, the only improvement was noticed after a period of non-treatment in the AB design. This elevation of scores may have been due to practice effects, because the same testing instrument was used at each phase of the schedule.

Self-Esteem and Locus-of-Control scores were expected to improve as measured by the ISE and LOC. Scores were anticipated to reveal a positive attitudinal shift because of a sense of accomplishment with an improvement of attentional skills. Self-esteem and Locus-of-Control counts seem to be more representative of the immediate

circumstances (states) than of attitudes (traits). The repercussions following a simple incident may be significant for these individuals, and may have a considerable effect on their everyday living arrangements. For instance, if we encounter a problem, like a dead car battery, we simply call a garage and get a boost or buy a new battery. When one of the participants experienced the same kind of problem (a dead wheelchair battery), he was up against considerably more barriers, to the extent of being confined to his home for weeks.

If we stay out too late, we face the consequence of having difficulty rising the next day. But, when a participant stayed out too late in a supervised setting, he was not allowed back into the house and had to make alternative arrangements at the Salvation Army, for several nights.

It is not surprising that three out five participants had a clinical problem with self-esteem throughout testing. Also, it is not surprising that their circumstances should affect the scores on Locus-of-Control when each predicament produces such extreme consequences.

The one participant who showed positive shifts on both measures was Ea. At the time of the testing schedule this 30-year-old adult was making a change in living arrangements, from his parents' home to living independently.

As forecasted, there were no consistent advancements in the visuo-spatial scores. It may be that there was not enough variance within the testing instruments to demonstrate a differentiation or the scores on the visuo-spatial measures show preserved function. It should be noted (as predicted) that all of the participants were within the normal range for visuo-spatial functions across all sessions. (See Table 2.)



Therefore, it seems that a severe attentional deficit can exist within one domain to the exclusion of another domain. This sparing of function is particularly visible when one compares Ea's performance on attentional and memory measures to his performance on visuo-spatial indicators.

When compared to pre-treatment reports, general functioning did not improve across all participants as anticipated. There were no appreciable gains reported at final testing as measured by the General Functioning Questionnaire, with the exception, again, of Ea. His father reported an improvement in confused state and in his ability to carry on meaningful conversation.

### **Rehabilitative Implications**

The only consistent gains across categories were with the participant Ea who was two years post-injury. This may indicate that rehabilitation should begin at an early stage post-trauma to realize any significant benefits.

For the participants with prolonged treatment delays, it may be necessary to incorporate a longer treatment phase in their therapeutic plan. Perhaps a variety of attentional strategies and tasks could be part of their daily treatment. For example, Aa improved after treatment on certain attentional and memory components, however, the improvement did not endure to final testing. Certainly, for persons with a treatment delay, improvement on measures were scattered, but as one father reported "any improvement at this point is a plus." Moreover, it may be the case that the increment of improvement may be so discrete that it is not observed because our measures were not sensitive to the change.

There seems to be little evidence that attentional training procedures are clinically reliable (Wood, 1990). In fact, Batchelor, Shores, Marosszeky, and Sandanam (1988) compared computer-assisted cognitive training to non-computerized cognitive training in a group of 34 brain injured adults and found that there was no significant difference between the two modes of therapy. However, rehabilitation resources are not always available to survivors of brain injury and when one considers the time-efficiency involved in delivering a computer-mediated intervention, the practical choice is clear. The computer-mediated attentional system is a time efficient way of introducing training. Without advocating that attentional training should rely on computer mediated technology, it does seem advisable to not overlook computer programmes. The Captain's Log is a representative computer system used in rehabilitation centres. It delivers clear instructions and the stimulus presentation is consistent and repetitive. In addition, the feedback is immediate. Captain's Log may not make the best use of current technology which is growing more sophisticated with the passage of time. With voice actuation and touch control, it seems possible to generate an attentional intervention that would more appropriately fit the needs of individuals with a cognitive challenge.

The ability to understand one's own level of attentional resources or one's level of distractability may be one of the prime goals of this computer system. Explicitly demonstrating the areas of difficulty with regard to attentional capacity may improve self-awareness of certain problems. Disturbances in awareness are not very well understood but have been recognized in neuropsychological rehabilitation for some time (Prigatano, 1991). In the discussion section on Aa, there was mention of a

change noticed by participant's father. He observed that his son was more aware and more distressed about his aggressive behaviour. Perhaps as a result of the attentional training, he was able to consider his impulsive behaviour.

If computer mediation for attention therapy presents too many obstacles, we may consider a different mode of presentation. Sohlberg and Mateer (1989) have put together a programme of hierarchically arranged tape-recorded attentional tasks. They report success within this "process specific" approach to therapy, which has an impressive delivery of the material, particularly the section on alternating attention.

If a person suffers from an attentional deficit, activities of daily living can be compromised. He/she can have difficulty with conversation or instruction, lose track of story content when reading or watching television, and generally experience frustration as a result of slower mental processing. Rehabilitative programmes must address this cognitive problem. One participant experienced gains in most areas of testing, while the other participants realized improvements within only some areas of the rehabilitation programme.

If we optimistically interpret the results of this study to indicate that some improvement over time is attributable to cognitive rehabilitation (whether computer based or not), perhaps there is room for hope with the Captain's Log and other similar computer systems. Captain's Log is dependent only on an inexpensive microcomputer system and so individuals may facilitate further change by continuing their rehabilitation at home for considerably longer than the 16-week period of this study.

### **Educational Implications**

The Hugh MacMillan Rehabilitation Centre recently (1990) released a video and a guide for educational purposes that predicts that one out of every 20 children born today will be killed or severely injured by the age of 15. The majority will be brain injuries due to traffic accidents. The survival rate of young people who suffer the effects of brain injury are enhanced because of design modifications to vehicles and improvements in emergency interventions. Often "normal" in physical appearance and in casual conversation, these students frequently experience learning difficulties and failure in school.

Students with brain injuries can be accommodated in most classrooms with some minor modifications. Given that these students have a problem attending, remembering, listening, and comprehending, they may require the development of new skills before they can process new information. Repetition, multimodal cueing, and an individualized pace of instruction are all considerations and are all available through appropriate software packages. For the student who demonstrates a persistent difficulty with writing, the use of the computer would decrease the demand for written work. The use of appropriate software packages and placement in a small, quiet, highly-structured classroom may also help these children focus and sustain their attention.

When assessing attentional deficits, it is critical to have a highly sensitive measure. The Attentional Capacity Test (Weber & Segalowitz, 1990) was modified for use with children. I found this test to be extremely sensitive with the brain-injured population. The ACT can be used with children who are experiencing motor

and/or speech problems. It is not contaminated by other learned skill factors and can be used across a wide range of functional levels. A tape recorded message delivers the information, the examiner simply provides the instructions and records the responses: a very useful tool for quantifying attentional deficits.

### **About Attention**

Sohlberg and Mateer (1989) included five hierarchical stages in their study. They were unable to recognize the relative contribution of the components of the program or whether it is critical to work within each of the five levels. Although the delivery of the program differed, the outcome is the same. After perusing the computer task sheets, there was no evidence that any one attentional component contributed more than another. There was a gradual improvement over all attentional tasks within the program concurrently. Likewise, there was no evidence whether it is critical to work within each of the five levels.

### **Research Limitations**

Many of the testing instruments had to be slightly changed so that the devices were appropriate for use within this population. Unfortunately, that meant that the norms were no longer valid and the standard deviations could not be reported. A great amount of time and effort went into the selection and modification of each test within both studies but, in the future, established norms would be a benefit.

The time element is also a consideration. Eight weeks of treatment seemed enough time for the person with the shortest therapy delay (two years) but for those

persons with a longer delay the time could be extended. The subsequent study could extend the treatment phase to detect any change in behaviour.

Ideally, an increase in the number of participants would improve the power quotient and a matched control group would make a comparison uncomplicated. However, the ideal conditions are not always attainable.

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## Appendix A: CONSENT FORM

## THE EVALUATION OF REHABILITATIVE STRATEGIES

I \_\_\_\_\_, consent to take part in a study involving the evaluation of rehabilitative strategies for persons who have experienced a head injury. The long range goal of this study is to make rehabilitation more effective.

It has been explained that I will be asked to attempt various tasks that are designed measure my ability to attend and solve puzzles. Further, I will be asked to respond to questions about how I feel.

I understand that I may be asked to participate in more than one testing session, but the time and nature of the tasks will be explained to me prior to my agreeing to participate in each session.

I understand that I may feel as if I went back to school after doing these tests but I will not be affected in any adverse way from my participation. These tests can be fun and interesting and I will be given some general feedback about my performance but there will be no benefit or cost to me.

I also understand that I may withdraw from this study at any time, even after signing the form.

_____ NAME	_____ SIGNATURE	_____ DATE
_____ WITNESS	_____ SIGNATURE	_____ DATE

I have explained the nature of this study to the individual and believe that he/she has understood it.

_____ NAME	_____ SIGNATURE	_____ DATE
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## Appendix B

### Index of Self-Esteem (ISE)

Availability: The Dorsey Press. 224 South Michigan Avenue, Suite 440, Chicago, Illinois. 60604.

This questionnaire is designed to measure how you see yourself. It is not a test, so there are no right or wrong answers. Please answer each item as truthfully and accurately as you can by using the number system as follows:

- 1 = rarely or none of the time
- 2 = a little of the time
- 3 = some of the time
- 4 = a good part of the time
- 5 = most or all of the time

1. I feel that people would not like me if they really knew me well.
2. I feel that others get along much better than I do.
3. I feel that I am a beautiful person.
4. When I am with other people I feel they are glad I am with them.
5. I feel that people really like to talk with me.
6. I feel that I am a very competent person.
7. I think I make a good impression on others.
8. I feel that I need more self-confidence.
9. When I am with strangers I am very nervous.
10. I think I am a very dull person.
11. I feel ugly.
12. I feel that others have more fun than I do.
13. I feel I bore people.
14. I think my friends find me interesting.
15. I think I have a very good sense of humour.
16. I feel very self-conscious when I am with strangers.
17. I feel that if I was more like other people I would have it made.
18. I feel that people have a good time when they are with me.
19. I feel like a wall flower when I go out.
20. I feel I get pushed around more than others.
21. I think that I am a rather nice person.
22. I feel that people really like me very much.
23. I feel that I am a likeable person.
24. I am afraid that I will appear foolish to other people.
25. My friends think very highly of me.

## Appendix C: Locus of Control

### Part 1: Desire of Outcomes

There are many activities or events that happen to us in everyday living. Some of these events are more desirable or more important to you than others. I will read to you statements that mention some of these activities or events. Would you please rate the extent to which each event described is important or not important to you. I want to emphasize that I am concerned the event's importance to you, not to others.

- 1 = very desirable
- 2 = desirable
- 3 = undecided
- 4 = undesirable
- 5 = very undesirable

1. How desirable is it to you that your friends come and visit with you regularly?
2. How desirable is it to you that people ask for your advice or suggestions?
3. How important is it to you that you maintain your health?
4. Is getting involved in various activities important to you?
5. Is being able to get along with the people you meet important to you?
6. How important is it to you to be able to do the things you like to do?
7. Is being able to arrange for outings important to you?
8. Is being able to contact your family whenever you want important to you?
9. How important is it to you to spend your time doing whatever you want?
10. How important is it that you do the chores yourself without any help?
11. How much do you enjoy getting involved in interesting activities?
12. See #3.
13. Is having your friends and family visit when you invite them important to you?
14. See #7.
15. How important is it to you to have a say about where you are going to live?
16. Is making people happy important to you?

## Pre-Training Interview

I understand that \_\_\_\_\_ is not living at home at the present time. Because you have contact with \_\_\_\_\_, there are a few questions that I would like to ask you before I start this new program. Please be as specific as possible. Your time and effort in this matter is greatly appreciated.

1. When you are visiting with \_\_\_\_\_ what kinds of things does he do?
  - a) Does he help with chores?
  - b) If so, describe what he does and what you think about how well he does it.
2. Can you tell me what his attention is like?
3. Can you describe some tasks he has done and what the results have been.
4. What are your concerns about him?
5. What are your concerns about his ability to perform, to function effectively?
6. Describe how he interacts with other people.
7. Does he ever appear to have difficulty concentrating or remembering?
8. What does he do well? What are you satisfied with?
9. What do you hope for him in the future.

If you have any concerns regarding the questions, do not hesitate to call me at home (111-1111).

Dianne Henderson

## Appendix D: General Functioning Questionnaire

### Post-Training Interview

\_\_\_\_\_ and I are at the end of this phase of the program. Again, because you have contact with \_\_\_\_\_, there are a few questions that I would like to ask you. Please be as specific as possible. Your time and effort in this matter is greatly appreciated.

1. When \_\_\_\_\_ is at home what does he do?
  - a) Does he help with chores?
  - b) If so, describe what he does and what you both think about how well he does it.
2. Can you tell me what his attention is like?
3. Can you describe some tasks he has done and what the results have been?
4. What are your concerns about him?
5. What are your concerns about his ability to perform, to function effectively?
6. Describe how he interacts with other people.
7. Does he ever appear to have difficulty concentrating or remembering?
8. What does he do well? What are you satisfied with?
9. What do you hope for him in the future?

If you have any concerns regarding the questions, do not hesitate to call me at home (111-1111).

Dianne Henderson

P.S.

If you have noticed any other changes that are not addressed in this interview, please include them as well. I am not testing your memory from one interview to the next, I am simply interested in any noticeable changes that \_\_\_\_\_ may have undergone during the training.



## Kendrick Object Learning Test (KOLT)

## 2. Uses of the Tests

### A. Diagnosis

For diagnosis it is essential that the two tests be used in conjunction with each other and if possible with a retesting six weeks later.

#### *Screening for Dementia*

As an initial step in screening for dementia, the tests show a high level of accuracy (cf. Table 9 and Section 6). It is expected that a diagnosis of dementia from the tests will be confirmed from other sources, e.g. neurological, psychiatric, etc. It is not known if the tests in their present form differentiate between the various forms of dementia, especially Senile Dementia of the Alzheimer Type (SDAT) and Multi-infarct Dementia.

#### *Differential Diagnosis*

The tests can also be used to discriminate between elderly people who may be dementing, showing a depressive pattern of responding or normal responding (cf. Table 10). Here, the diagnosis is less accurate than the screening method but nevertheless it can contribute to unravelling the problem of pseudodementia.

### B. Research

The tests can be used separately for research purposes. The KOLT is especially interesting here as the objects on the cards form three distinct groups: (i) repeated items; (ii) category or concept items; and (iii) filler items. Although in diagnosis only the total score is used, in research it could be valuable to consider the three component scores. For example, in the pilot study to the validation of the KOLT it was found that people recovering from heart failure had a similar pattern of scoring on the three component parts to the dementing subjects (cf. Section 6).

The KDCT can be used as a simple means of measuring the speed of continuous responding as opposed to reaction times.

## 3. Administration and Scoring

The examinee should be seated comfortably at a desk or table in a well-lit area. Care should be taken to ensure that the examinee can hear the instructions adequately and can see the tests properly, and that there are no other incapacitating conditions (e.g. arthritic hands). Each examinee should be supplied with a ball-point pen.

The examiner needs a stop-watch, or preferably a digital watch with stop-watch functions, and a copy of the protocol on which to record the examinee's responses to the KOLT. It must be ascertained that the examinee understands the instructions for both tests adequately.

*When used as a battery for diagnostic purposes the tests are always given in the order KOLT followed by KDCT.*

### Administration of the KOLT

Form A or B may be administered initially, but if retesting is carried out, the alternative form should be used on that occasion.

Ensure that the four cards are in their correct order. Say to the examinee:

**Here I have four large cards. On the cards there are some pictures of various common objects you should recognize. I want you to look at the objects and try to remember as many of them as possible, for in a short while the card will be turned over. When the time is up, I want you to tell me as many of the things you saw as possible. You can tell me them in any order. Is that clear?**

If the examinee does not seem to understand, repeat the instructions.

*You may tell the examinee how long they will be able to view a particular card as you hand it to them.*

The time allowed for inspection of each card is based upon a three second viewing time per object. The times are shown in Table 2. Timing is best done unobtrusively.

**Table 2 Inspection times**  
Form A or B

		No. of items
Card 1	30 seconds	10
Card 2	45 seconds	15
Card 3	60 seconds	20
Card 4	75 seconds	25

Examinees sometimes quite spontaneously begin to name the objects on the cards. This is permissible. They may also hand a card back before the time limit has been reached. In this case hand it back again and say:

**Keep looking until I ask you to stop.**

## Kendrick Object Learning Test (KOLT)

KOLT  
Form A

## Card 1

30 seconds

Cat		Bed	Watch	
Key			Banana	Horse
		Specs		News- paper
				Spoon
	Jug			

Other responses:

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No. correct

## Card 2

45 seconds

Crab	Gun	Bed	Doll	
Key			Banana	Fly
Tree		Specs	Umbrella	Scissors
	Car			Spoon
	Jug	Lion		

Other responses:

---



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No. correct

## Card 3

60 seconds

Fish	Aero- plane	Bed	Coin	
Key		Flag	Banana	Snake
Candle		Specs	Matches	Pen
Playing card	Tele- phone		Hen	Spoon
Sauce- pan	Jug	Baboon	Violin	

Other responses:

---



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## Card 4

75 seconds

Mouse	Tooth- brush	Bed	Vase of flowers	Mug
Key	Suit- case	Ship	Banana	Pig
Envelope	Cow	Specs	Baby	Kettle
Bush	Neck- lace	Wine glass	Elephant	Spoon
Ball	Jug	Fox	House	Paint- brush

Other responses:

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## Appendix F

### The Attentional Capacity Test

Level	Requirements
1	Repeat single items
2	Count the number of "ee" sounds in a sequence of ee's
3	Count the number of "8's" in a series of 8's
4	Count the number of "8's" that are mixed in with other numbers
5	Count the number of "8's and 5's" that are mixed in with other numbers...for one total
6	Count the number of "8's, 5's, 4's, & 7's" that are mixed in with other numbers..one total
7	Count how many number pairs "4-7 & 5-8" that are mixed in with other numbers...one total
8	Count the number of sequences "5-number-8" that are mixed in with other number. The number in the middle can be any number from 1 to 10 and it is possible to have overlaps. i.e. 5-5-8-8

Testing is discontinued if a client scores 0 on two successive levels.

# Form C-W Stimulus Sheet

## Appendix E - Stroop

88

BLUE	GREEN	RED
GREEN	BLUE	GREEN
RED	RED	BLUE
TAN	BLUE	TAN
GREEN	TAN	RED
BLUE	RED	TAN
RED	GREEN	BLUE
TAN	TAN	TAN
RED	GREEN	RED
BLUE	BLUE	BLUE
RED	RED	RED
TAN	TAN	TAN
BLUE	GREEN	BLUE

GREEN

TAN

RED

TAN

BLUE

TAN

GREEN

RED

GREEN

RED

BLUE

GREEN

TAN

BLUE

GREEN

RED

GREEN

TAN

GREEN

BLUE

TAN

BLUE

GREEN

RED

BLUE

GREEN

RED

BLUE

TAN RED GREEN

\*\*\*\*\*only 39 items were used  
RED BLUE TAN

BLUE GREEN BLUE

GREEN RED TAN

TAN GREEN BLUE

GREEN BLUE RED

TAN TAN GREEN

RED GREEN BLUE

BLUE RED GREEN

RED TAN BLUE

TAN BLUE GREEN

RED TAN RED

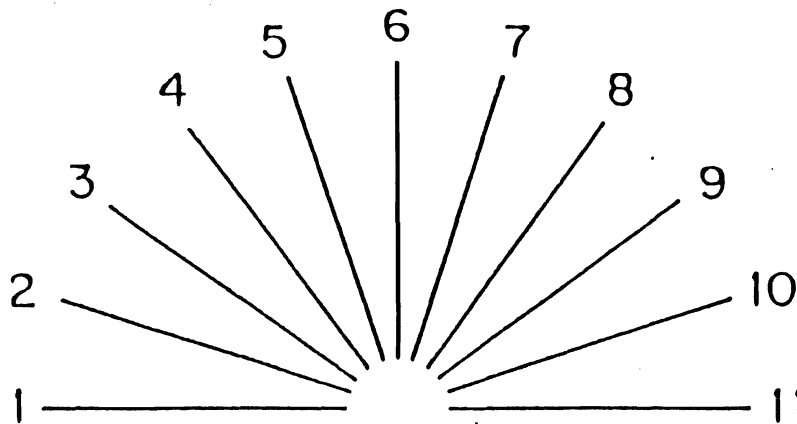
TAN RED GREEN

GREEN TAN TAN

TAN GREEN RED

Judgement of Line Orientation (JOL0)

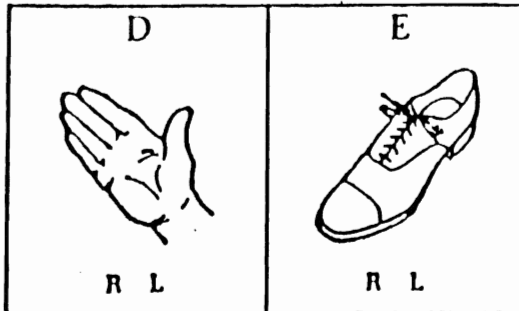
The participant is required to identify the direction of the lines.



## Right/Left Discrimination

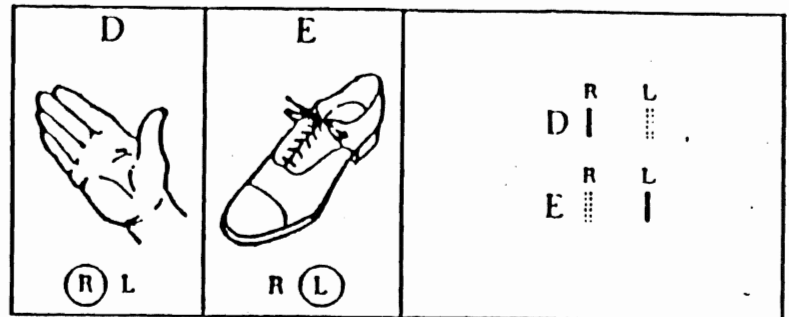
**DIRECTIONS: Mark as you are told the letter, R, for each picture that shows a right, L, for each picture that shows a left.**

Samples D and E

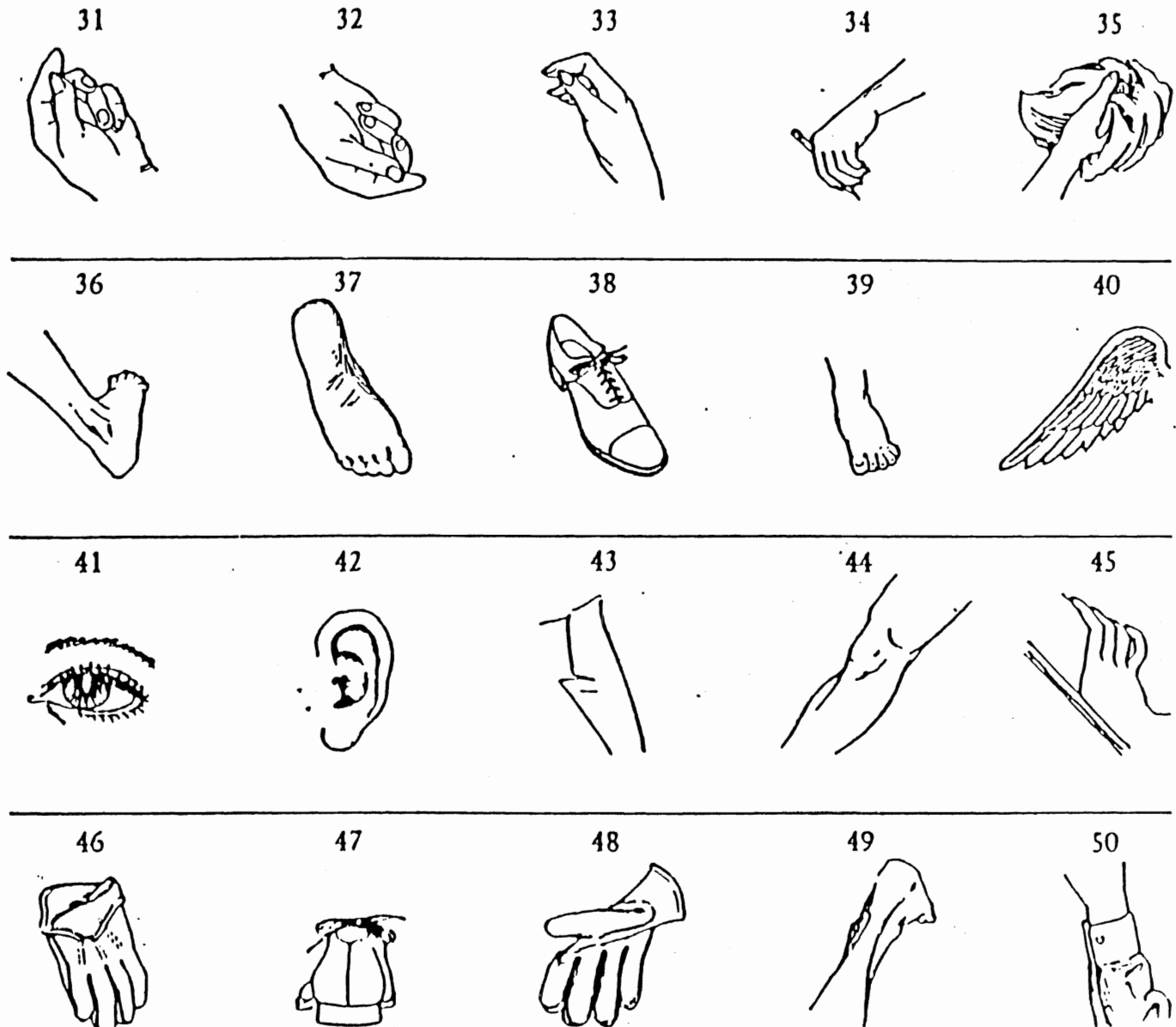


Correct Test Booklet Marks

Correct Answer Sheet Marks



## TEST 3



## Appendix J

### Durrell Analysis of Reading Difficulty

#### Listening Comprehension

#### Sample of Grades Level One and Two:

##### 1. The Cat and the Dog

A boy had a big gray cat. He was going to give her some milk. She did not come when he called. He saw her up in a tree looking down at a big dog. The boy sent the dog away. Then the cat jumped down from the tree and came for her milk.

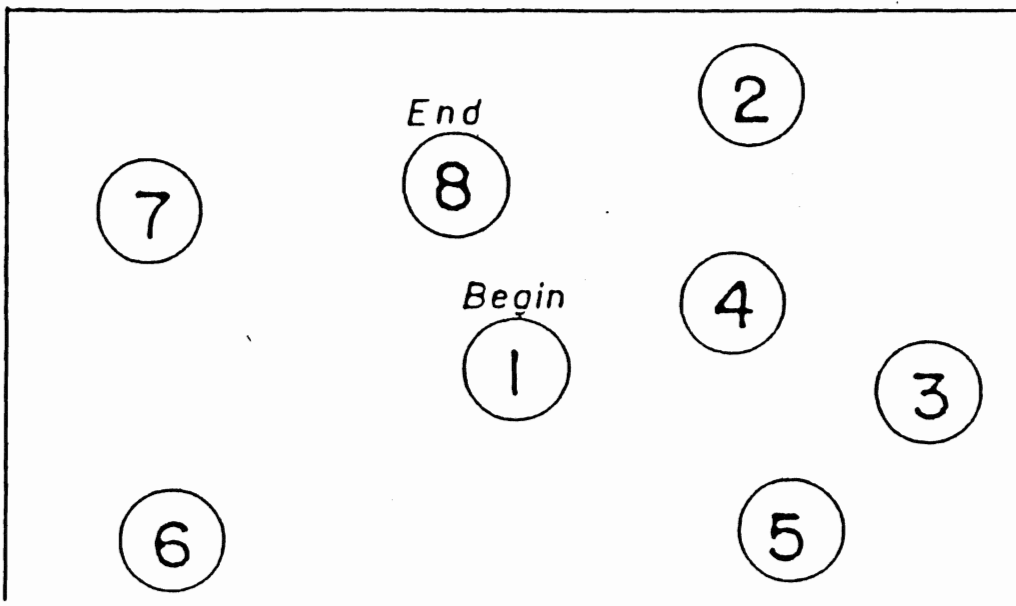
##### 2. Dick's Birthday Present

Dick jumped out of bed and ran downstairs. It was his birthday. He found a big basket on his chair at the table. Something was moving in the basket. Dick took off the cover. Out jumped a little brown dog. The dog started to bark and wag his tail. He was glad to get out.

# TRAIL MAKING

## Part A

### SAMPLE





## Appendix L

### Memory Paragraphs

#### Story Instructions

I am going to read you a little story of just a few lines. Listen carefully and try to remember it just the way I say it, as close to the same words as you can remember. When I am through I want you to tell me everything I read to you. You should tell me all that you can remember, even if you are not sure. Are you ready?

Read Story A, B, or C.

Story C will be shown because it was the story that was modified for use in Study #1 and #2.

#### Story C

The Canadian / patrol boat / Dartmouth / struck / an iceberg / off the coast / of Labrador / Monday / evening /. In spite of strong winds / and darkness / the fifteen / crew members / including four / women / were all rescued / though the lifeboats / were tossed about / like corks / in the sea /. They were brought into port / the next day / by a Portuguese / trawler.

Now, what did I read to you? Tell me everything and begin at the beginning.m

Text for Story C	General Rule	Examples of Alternative 1-Point Responses	Examples of 0-Point Responses
The Canadian	"Canada" (in any context)	from Canada	an American
patrol boat	"patrol" boat is required	patrol ship	frigate, schooner
Dartmouth	"Dartmouth" (in any context)	from, or on a trip to Dartmouth	--
struck	a word or phrase meaning "struck"	smacked, ran, smashed, or collided into	slipped into, bumped, tapped
iceberg	"iceberg" is required	--	piece of ice
off the coast	"off the coast" (in any context)	off or outside of the coast or shoreline	--
of Labrador	"Labrador" (in any context)	on the way to Labrador	--
Monday	"Monday" is required	--	early in the week, or names another day of the week.
evening	Indication that the collision occurred in the evening.	in the evening, at dusk	one night, at night
In spite of	"in spite of" (in any context)	despite, even with	--
strong winds	"winds" or a synonym	gust, gale, heavy winds, high winds	breeze, draft, typhoon, cyclone

and darkness	"darkness" or a synonym	dark, blackness, obscurity	dimness, shade, eclipse, cloudiness
the fifteen	greater then 12 less then 20	over 13, about 14, 14 or 15	20 crew, a lot of, several
crew members	"crew" or a synonym	hands, seamen, mariners, ship's company, members of the crew	squad, troupe,
including 4	"4" is required	There were 4 women aboard.	any number other then 4, some.
women	"women" or a synonym	females, ladies	dolls, chicks
were all rescued	Indication that all were rescued	all were saved or rescued, everyone was saved	some were saved or rescued, no one was saved, all perished
though the lifeboats	"lifeboats" or a synonym	life dinghy, life raft or dory	ship, barge, canoe, kayak,
were tossed about	"tossed about" or synonym	hurled, pitched, heaved about	moved, bobbed, wobbled about
like corks	"corks" or a synonym	bobbing, corking	--
in the sea	Indication that water was involved.	in the water, in the ocean,	in the lake,
They were brought into the shore	Indication that they were brought to shore.	taken to port, returned to shore, brought to the coast	rescued
the next day	Indication that they returned the next day.	the following day, the day after, the day later.	that day, a week later,
by a Portugese	"Portugese" in any context.	from Portugal, hailing from Portugal	--
trawler	"trawler" or a synonym	ship, vessel, barge, tanker	dinghy, dory, raft, canoe.

## Appendix M

## The Randt Memory Test

## FIVE ITEMS

	acquisition	after digits	) 24 hrs.	
rain	...	...	...	...
skirt	...	...	...	...
sky	...	...	...	...
car	...	...	...	...
dog	...	...	...	...
32	44 76	49 82 95	35	58 86
TOTAL:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## PAIRED WORDS

	acquis.	after story	) 24 hrs.	
note-				
book	...	...	...	...
brush-				
door	...	...	...	...
king-				
queen	...	...	...	...
bone-				
spot	...	...	...	...
bird-				
seed	...	...	...	...
hand-				
foot	...	...	...	...
42	37 71	46 65 88	92	31 59
TOTAL:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## PICTURE RECOGNITION

	acquis recog	) inc. lrn. recog. rcl	) 24 hrs. recog. rcl
broom	+	+	+
2 lamp	..	..	..
nose	..	..	..
4 book	..	..	..
comb	..	..	..
6 trousers	..	..	..
trumpet	..	..	..
bed	..	..	..
1 bucket	..	..	..
piano	..	..	..
bird	..	..	..
3 plate	..	..	..
stairway	..	..	..
5 cow	..	..	..
7 pear	..	..	..
TOTAL:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Appendix N**  
**Captain's Log**  
**An Example of One Module**

T H B X N B M H S B N W E P A Q R V S Z  
T B V Z B Q X G U Y A C B R D C Y P V R  
O I A M K A C A C A P G Y G J C Q P V U  
Q T I F Q

CLICK MOUSE WHEN 'B' APPEARS.

TASK: SCANNING REACTION TIME  
NAME: CAPTAIN DATE: 04/05/87

-----  
CORRECT RESPONSES: 17 94.4%  
AVERAGE REACTION TIME: 0.49 SECONDS  
RESPONSE ERRORS: 4  
NON-RESPONSE ERRORS: 1 POINTS: 870  
-----

DIFFICULTY: INTERMEDIATE  
DELAY: 1 SECOND RESPONSE TIME  
DISPLAY TYPE: LETTERS/NUMBERS  
AUDITORY: FEEDBACK ON  
TIME: 1 MINUTE  
HAND USED: RIGHT HAND  
MODE: TRAINING